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PRELIMINARY DATA FROM THE MAY 28, 1974 SIMULTANEOUS EVALUATION OF REMOTE SENSORS EXPERIMENT

By Robert W. Johnson, Carmen E. Batten, David E. Bowker, Walter E. Bressette, and Gary W. Grew

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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16. Abstract

The National Aeronautics and Space Administration and the Environmental Protection Agency are working on a joint program for developing remote sensors and data analysis techniques for determining synoptic pollution levels. On May 28, 1974, several remote sensors were simultaneously used to collect data over the tidal James River from Hopewell to Norfolk, Virginia. Sensors evaluated included the Multichannel-Ocean Color Sensor, multispectral scanners, and multispectral photography. This report provides for initial release of ground truth measurements and remotely sensed data; any detailed analyses and reporting will be provided by participating investigators. Preliminary analysis indicates that suspended sediment and concentrated industrial effluent are observable from all sensors.

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INTRODUCTION

The NASA Langley Research Center is working with the Environmental Protection Agency (EPA) in a joint program of developing remote sensors and data analysis techniques to determine synoptic pollution levels and their distributions. The objectives of the program are (1) to develop and evaluate remote sensing techniques for the detection and monitoring of substances and processes which affect water quality, and (2) to develop analytical techniques which will permit more effective use of remotely sensed data in water pollution monitoring and environmental assessment.

Sensors being evaluated in this program include the Multichannel-Ocean Color Sensor (MOCS), multispectral scanners (MSS), and multispectral photography (MSP). The MOCS system is an experimental airborne scanner that has been flight tested (e.g. Grew, ref. 1). Multispectral photography from aircraft platforms has been studied by Bressette and Lear (ref. 2). Multispectral scanners, which include the sensors on the LANDSAT-I satellite have been evaluated by Bowker, et al (ref. 3) and Klemas, et al (ref. 4). Airborne multispectral scanners have been developed and flight tested by the NASA Johnson Space Center and Bendix Aerosystems Division. The particular multispectral scanner flown on this mission is a Bendix Modular Multispectral Scanner (M2S). All of these sensors are still in a quasi-operational stage in terms of water quality monitoring since both the measurement and analysis techniques are in a state of development. In addition, evaluation of each of these sensors has been, to date, approached independently; that is, by comparison with conventionally gathered ground truth measurements or aerial photographs.

It was one of the purposes of this experiment to simultaneously collect data by all of these remote sensors over the same area. Then parallel analyses may be made and transfer of information used to refine and/or extend the capability of each of the sensors. In addition, direct comparisons aid in formulation of future sensor research programs. Considering the above and the current status of instrument development and data interpretation at the Langley Research Center, the following mission objectives were established:

1. Gather and analyze both ground truth and remotely sensed data to support LaRC sensor and other programs; specifically

a. Ground truth (sampling and laboratory analysis)
b. Other sensors such as M2S and LANDSAT
c. Data analysis capability to aid in interpretation of sensor measurements

2. Assess current effectiveness of some remote sensing techniques available to LaRC to assess water quality parameters.

Investigators and their areas of responsibility for this effort were as follows:

Principal Investigator	Dr. Robert W. Johnson
M.S. Photography	Walter E. Bressette
MOCS	Gary W. Grew
MSS (LANDSAT-I)	Dr. David E. Bowker
M2S (Aircraft)	Dr. Robert W. Johnson & Ruth I. Whitman
Ground Truth & LaRC Laboratory Analysis	Carmen E. Batten

On May 28, 1974, data were collected using the above remote sensors in conjunction with concurrent ground truth measurements. The latter included in situ measurement as well as water samples for subsequent laboratory analysis.

It is the purpose of this report to provide a mission overview, a "quick look" at the data collected and an assessment of mission effectiveness. Any detailed analyses of the data collected will be provided by the individual investigators on the mission.

LOCATION OF EXPERIMENTAL AREAS

The primary experiment areas were the Army Base Sewage Treatment Plant (ABSTP) outfall in Hampton Roads (Norfolk site) and the upper reaches of the James River near Hopewell (Hopewell site), as identified in figure 1. In addition to the two primary sites, remotely sensed data were collected over the intermediate James River and the Chickahominy River. Remotely sensed data were collected using aircraft and satellite platforms. Aircraft were the NASA, Wallops Flight Center, C-54 (MOCS and MSP) at 5.3 kilometers (KM) (17,500 ft) altitude and a Bendix twin engine Beechcraft (M2S) at 2.4 KM (8000 ft). LANDSAT-I is a satellite platform (700 KM altitude). Remotely sensed data collection occurred from about 1000 to 1150 hours, EDT. Flight lines and times are shown in figures 1 and 2 and Tables I and II, respectively.

In general, the aircraft started their data-taking in the Norfolk area at about 1000 hours, flew up the James River so that data-taking in the Hopewell area would approximate the LANDSAT-I overpass (1115 hours). The Wallops aircraft returned to the Norfolk area for an additional run at about 1145 hours.

Ground truth was collected by three boats at each of the primary test sites (by Old Dominion University at the Norfolk site and Virginia Institute of Marine Sciences at Hopewell). Sampling took place from about 0915 to 1235 hours. In addition to the primary sites, data were collected at the approximate time of the LANDSAT-I overpass (1115 hours EDT) near Hog Island and in the Chickahominy River. Ground truth station locations and sampling times are shown in figure 3 and Table III, respectively.

EXPERIMENTAL METHOD

Remote sensors that measure electromagnetic radiation in the visible and near-infrared frequencies were flown over the test sites. Frequency ranges and bands (where applicable) are shown in Table IV. In addition to a spectral range of measurements, remote sensors provide data over a much greater spatial area than may be effectively covered by ground truth sampling methods. Spatial coverage and remote sensor resolution are listed in Table V.

Multispectral Photography.- A bank of four Hasselblad cameras (as well as mapping cameras) were flown at an altitude of 5.3 KM (17,500 ft) on the Wallops aircraft. Pertinent information concerning cameras, film, filters, and exposure are listed in Table VI. The spectral transmittance of each filter is shown in figure 4. Filter-film combinations were selected to enhance chlorophyll a, suspended sediment, and other water quality parameters.

Multichannel Ocean Color Sensor.- The Multichannel Ocean Color Sensor (MOCS) unit was flown on the Wallops aircraft with the multispectral photography cameras. MOCS is a visible imaging spectroradiometer which performs multispectral scanning electronically and has no moving parts. It measures the intensity in 20 spectral bands (15 nanometers (nm) spectral resolution in a spectral range from 400-700 nm) at each of 150 pixels across the field-of-view. A schematic of the optical arrangement in the MOCS and a listing of its specifications is shown in figure 5.

Multispectral Scanner.- The Bendix multispectral scanner (M2S) has 10 bands in the visible and near-IR and a thermal band for a total of 11 bands, Table IV. A block diagram of the unit is shown in figure 6. Ground track width was about 6.8 kilometers (22,000 ft) at the flight altitude of 2.4 kilometers (8000 ft).

LANDSAT.- The LANDSAT-I satellite multispectral scanner has four bands in the visible and near IR, Tables IV and V. The LANDSAT-I overpass of the upper James River covered only test sites 2 (Hopewell) and 3 (Hog Island), figure 1.

Ground Truth and Laboratory Analyses.- Ground truth measurements in situ or by water samples with subsequent laboratory analysis were made for water quality parameters listed in Table VII at the primary test sites (Norfolk and Hopewell). Less extensive sampling occurred at test site 3 (Hog Island). Ground truth measurements were made at fixed stations from 0915 to about

1115 hours--the latter the time of LANDSAT overpass--to obtain a measure of system stability; then, after the LANDSAT pass, additional stations were occupied to obtain spatial coverage.

RESULTS AND DISCUSSION

Remotely sensed and ground truth measurements were taken in the Hampton Roads and James River, Virginia, areas from about 0915 to 1235 Hours on May 28, 1974. Complete ground truth measurements and remote sensor flight information are tabulated in Appendix A. The following sections present selected examples of data (imagery and photographs) obtained during the mission, along with a description of the data format.

Multispectral photography of test site 2 (Hopewell) is shown in figure 7. Sunglint is obviously at least a marginal problem due to the high sun angle at this time of the year. In addition, the sun image is increased due to increased water surface roughness caused by the wind. Sunglint covers up to about two-thirds of the water and in this extreme case would require about 75 percent overlapping photography to assure complete water coverage without sunglint.

Observation of frame 45 indicates suspended sediment and probably some bottom effects (by comparison of the number 12 and 89 B filter photographs). Ground truth measurements indicate the absence of chlorophyl blooms. Industrial plant discharge via Baileys Creek (located at right-center) is also indicated in this frame.

Bright areas in the center of all the photographs through the B-3 BAIRD-Atomic optical filters are not caused by sunglint, but are the result of overexposure and development of the center of the photograph. This effect has been shown in previous work (ref. 2) to be due to off-axis falloff and is apparently due to the particular filter-camera combination; this effect can be avoided in future missions by using an F-number of 5.6 (rather than the F-4 used in this mission).

Digital data were collected with the MOCS unit over the primary test sites (Norfolk and Hopewell) as well as the intermediate James River. Results of preliminary data analysis in the Hopewell area show industrial effluent and turbid water as some of the outstanding features along scan line 41, see figure 8. Point by point analyses and identification were made along line 41 using ratios of bands, figure 9. Specific identifications, which are preliminary, are based on ground truth and photo analysis. Figure 9 is useful for qualitative separation of features such as land, industrial effluent, and turbid water. Regression analysis may be used to develop quantitative relationships and to identify spectral signatures.

Screening imagery developed from the multispectral scanner digital data is shown in figure 10 for the three test sites. Band 5, 0.58 to 0.62 micron frequency (yellow spectral region), was used since this shows gross water circulation patterns using sediment as a natural tracer. In addition, as

was observed in frame 45 of the multispectral photography section (see fig. 7), industrial effluent may be seen flowing from Baileys Creek which is located in the lower center of the image. It should be recalled that since the data format from the M2S is digital, computerized data analysis techniques may be used. In addition, spatial registration problems (which occur with microdensitometer treatment of photographs, for example) are precluded.

LANDSAT-I multispectral scanner imagery has the essential features of the airborne unit except there are only four bands, and resolution is somewhat less (about 70 meters for LANDSAT, 7 meters for M2S) due to the greater satellite altitude. LANDSAT I imagery for Band 5 (0.6 to 0.7 microns) is shown in figure 11. As has been indicated by a number of investigators (e.g. Klemas, et al ref. 4), sediment patterns are readily observed.

CONCLUDING REMARKS

In general, the May 28, 1974, data collection mission using a number of remote sensors in conjunction with concurrent ground truth can be considered successful from the mission planning and operations viewpoint. Analysis and interpretations of the photographic and digital data have not been completed, however, and refinement of techniques will continue.

Results of analyses to date are as follows:

1. From a photographic viewpoint the mission altitude was satisfactory. For the lower reach, Norfolk, about 90 percent of each photograph was water; however, in the upper reach, Hopewell, only about 50 percent of each photograph was water. (Note that the constant 5.3 KM altitude was required by the MOCS.)

2. All of the remotely sensed data in the test sites were essentially concurrent with, or bracketed by, ground truth measurements.

3. There is a good deal of sunglint in the photographs since parts of the mission were flown during the sunglint period; however, the 50 percent overlapping pictures resulted in acceptable photography for nearly the complete river area.

4. The F-4 number for the two B-3 BAIRD-Atomic filters (on Hasselblad cameras) resulted in overexposure of the center portion of each photograph. It is recommended that an F-5.6 number be used in future work with these filters.

5. Sunglint and other environmental effects were not significant on the spectrometer type sensors.

6. Suspended sediment, thus gross water circulation patterns, are readily detectable by all of the remote sensors.

7. The collection of ground truth at fixed stations until sensor overpass followed by movement to additional stations appears to be an effective method for determining system transients as well as providing spatial coverage.

APPENDIX

See Table III for times of water sampling and remote sensing data collection.

BENDIX FLIGHT 92 LANDSAT-I IMAGE 1674-15131 WALLOPS FLIGHT 276

LOCATION-BOAT	TAPE	TIME	LINE	COL	TAPE	TIME	LINE	COL	TIMES	
NORFOLK S1 SURFACE	3406039 RUN 3	1037	7	506	-0	-0	-0	-0	948	1149

TIME (EDT), HOURS	915	935	955	1002	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SN1	SN1A	SN1B	SN1	SN1C	SN1D	SN1E	SN1F	SN1G	SN1H	SN1I	SN1J
STATION	1	1	1	1	1	1	1	1	1	1	1	1
DEPTH METERS	3.60	3.60	3.60	3.60	3.80	3.80	4.00	3.60	3.60	3.60	3.80	4.00
SECCHI DEPTH METERS	.90	.90	1.10	.90	.90	.90	1.20	.90	1.10	1.20	.80	.90
CHLOROPHYLL A MG/M3	1.92	1.59	1.95	1.49	1.87	1.82	2.75	3.13	2.38	3.02	2.32	1.61
CHLOROPHYLL B MG/M3	.27	.16	.13	.09	.12	.02	.42	.21	.42	.03	.04	.05
CHLOROPHYLL C MG/M3	5.43	3.30	4.00	2.75	5.03	3.25	4.30	.08	4.42	2.57	3.65	4.13
PHAEOPHYTINS A MG/M3	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAROTENOIDS MG/M3	.07	.05	.04	.06	.02	.04	.06	.08	.07	.04	.05	.04
TURBIDITY MG/L	-0.00	-0.00	3.70	-0.00	-0.00	-0.00	-0.00	3.50	-0.00	-0.00	-0.00	-0.00
TOTAL SOLIDS MG/L	10.82	9.95	11.37	11.32	10.80	10.52	11.48	13.80	9.40	11.16	18.60	13.00
INORGANIC SOLIDS MG/L	5.39	6.14	7.76	-0.00	-0.00	-0.00	-0.00	8.83	-0.00	-0.00	-0.00	-0.00
TRANSMITTANCE PERCENT	1.50	3.00	5.00	1.50	6.00	5.50	5.50	4.00	6.00	5.00	0.00	1.00
WIND SPEED KNOTS	15.0	16.0	15.0	15.0	12.0	15.0	16.0	17.0	16.0	11.0	17.0	19.0
WIND DIRECTION DEGREES	315	315	315	315	315	315	315	315	315	315	315	315

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
NORFOLK S1 SURFACE	3406039 RUN 3	1037	7	506	-0	-0	-0	-0	948	1149

TIME (EDT), HOURS	915	935	955	1002	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SN1	SN1A	SN1B	SN1	SN1C	SN1D	SN1E	SN1F	SN1G	SN1H	SN1I	SN1J
STATION	1	1	1	1	1	1	1	1	1	1	1	1
CURRENT SPEED KNOTS	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	.31	.29	.33	.33	.33
CURRENT DIRECTION DEGREES	-0	-0	-0	-0	-0	-0	-0	116	134	129	133	131
TIDE MIN. SINCE MHW	41	61	81	88	101	121	141	161	181	201	221	241
TEMPERATURE DEGREES C	19.70	19.45	19.70	20.29	19.95	20.40	20.60	20.35	20.95	20.75	20.55	20.70
SALINITY PARTS/1000	17.590	17.620	17.600	16.850	17.580	17.620	17.690	17.690	17.690	17.720	17.620	17.690
DISSOLVED O2 MG/L	5.80	5.86	6.44	6.18	6.39	5.14	6.71	6.20	6.33	6.74	7.12	7.15
ACIDITY PH	7.58	7.58	7.18	7.37	7.58	7.53	7.51	7.50	7.58	7.68	7.78	7.67
INORGANIC NO2 MG/L	.0123	.0075	.0102	.0087	.0111	.0117	.00?5	.0087	.0093	.0102	.0075	.0093
INORGANIC NO3 MG/L	.1158	.0876	.1132	.1904	.0801	.1259	.1422	.1418	.0915	.1371	.0932	.1416
INORGANIC PO4 MG/L	.1089	.1012	.0930	.3175	.0918	.0918	.0965	.0949	.0934	.0794	.0482	.0747
FLUORESCENCE MG/L	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
SOLUB. ORG. CARBON MG/L	-0.0	-0.0	7.0	-0.0	-0.0	-0.0	-0.0	4.0	-0.0	-0.0	-0.0	-0.0
EXTINCTION (DECK) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00

LOCATION-BOAT	BENDIX FLIGHT TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	HALLOPS FLIGHT 276 TIMES	
NORFOLK S1 SURFACE	3406039 RUN 3	1037	7	506	-0	-0	-0	-0	948	1149

TIME (EDT), HOURS	915	935	955	1002	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SN1	SN1A	SN1B	SN1	SN1C	SN1D	SN1E	SN1F	SN1G	SN1H	SN1I	SN1J
STATION	1	1	1	1	1	1	1	1	1	1	1	1
EXTINCTION (SURF) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (.5 M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1.5M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (2. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT SPEED-1M KNOTS	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT DIR.-1M DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0
PARTICLES/MICRO-LTR (0-.5 MICRON BAND)	0.000	.253	0.000	0.000	.503	0.000	.253	.503	0.000	0.000	0.000	0.000
PARTICLES/MICRO-LTR (.5-1 MICRON BAND)	0.000	.503	0.000	0.000	2.270	0.000	0.000	.756	0.000	1.010	0.000	0.000
PARTICLES/MICRO-LTR (1-2. MICRON BAND)	37.900	49.000	26.000	26.300	54.800	27.000	51.900	46.600	25.500	42.100	39.400	33.300
PARTICLES/MICRO-LTR (2-4. MICRON BAND)	71.900	53.500	50.300	55.200	46.600	42.100	120.000	101.000	48.600	93.200	73.200	58.400
PARTICLES/MICRO-LTR (4-8. MICRON BAND)	23.500	27.000	17.900	17.400	13.400	15.900	38.400	42.100	20.900	30.300	23.700	24.000
PARTICLES/MICRO-LTR (8-16 MICRON BAND)	5.270	8.830	55.200	4.040	6.290	2.270	9.570	9.570	6.050	6.290	6.780	6.780

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
NORFOLK 01 DEPTH	3406039 RUN 3	1037	7	506	-0	-0	-0	-0	948	1149

TIME (EDT), HOURS	915	935	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	DN1	DN1A	DN1B	DN1C	DN1D	DN1E	DN1F	DN1G	DN1H	DN1I	DN1J
STATION	1	1	1	1	1	1	1	1	1	1	1
DEPTH METERS	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
SECCHI DEPTH METERS	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CHLOROPHYLL A MG/M3	1.93	2.03	1.95	2.05	2.75	2.93	2.97	2.60	2.82	2.23	3.63
CHLOROPHYLL B MG/M3	.21	.29	.20	.16	.17	.42	.24	.26	.09	.15	.71
CHLOROPHYLL C MG/M3	3.58	6.20	4.48	4.20	4.58	6.53	5.53	3.88	4.02	3.23	6.78
PHAEOPHYTINS A MG/M3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAROTENOIDS MG/M3	.05	0.00	.03	.04	.07	.07	.08	.07	.05	.05	.05
TURBIDITY MG/L	-0.00	-0.00	-0.00	3.60	-0.00	-0.00	4.40	-0.00	-0.00	-0.00	-0.00
TOTAL SOLIDS MG/L	20.46	8.08	10.91	7.96	8.92	10.36	14.52	13.64	14.04	16.04	11.08
INORGANIC SOLIDS MG/L	13.30	4.90	5.20	-0.00	-0.00	-0.00	10.00	-0.00	-0.00	-0.00	-0.00
TRANSMITTANCE PERCENT	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
WIND SPEED KNOTS	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
WIND DIRECTION DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
NORFOLK D1 DEPTH	3406039 RUN 3	1037	7	506	-0	-0	-0	-0	948	1149

TIME (EDT), HOURS	915	935	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	DN1	DN1A	DN1B	DN1C	DN1D	DN1E	DN1F	DN1G	DN1H	DN1I	DN1J
STATION	1	1	1	1	1	1	1	1	1	1	1
CURRENT SPEED KNOTS	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT DIRECTION DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0
TIDE MIN. SINCE MHW	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0
TEMPERATURE DEGREES C	20.15	20.48	20.36	20.60	21.35	21.39	21.43	21.41	21.60	21.66	21.33
SALINITY PARTS/1000	17.560	17.600	17.550	17.560	17.600	17.670	17.660	17.670	17.700	17.620	17.640
DISSOLVED O2 MG/L	5.97	7.01	6.52	6.42	6.29	6.12	6.35	6.82	6.52	7.25	6.66
ACIDITY PH	7.49	7.58	7.54	7.55	7.54	7.53	7.48	7.57	7.64	7.74	7.61
INORGANIC NO2 MG/L	.0072	.0099	.0089	.0093	.0087	.0087	.0117	.0081	.0093	.0081	.0099
INORGANIC NO3 MG/L	.1483	.0818	.1143	.1515	.1516	.1378	.1609	.1517	.1133	.0860	.1125
INORGANIC PO4 MG/L	.1089	.1105	.1385	.0918	.0933	.0965	.0934	.0887	.0778	.0560	.0872
FLUORESCENCE MG/L	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
SOLUB. ORG. CARBON MG/L	-0.0	-0.0	4.0	-0.0	-0.0	-0.0	4.0	-0.0	-0.0	-0.0	-0.0
EXTINCTION (DECK) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	HALLOPS FLIGHT 276 TIMES	
NORFOLK D1 DEPTH	3406039 RUN 3	1037	7	506	-0	-0	-0	-0	948	1149

TIME (EDT), HOURS	915	935	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	DN1	DN1A	DN1B	DN1C	DN1D	DN1E	DN1F	DN1G	DN1H	DN1I	DN1J
STATION	1	1	1	1	1	1	1	1	1	1	1
EXTINCTION (SURF) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (.5 M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1.5M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (2. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT SPEED-1M KNOTS	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT DIR.-1M DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0
PARTICLES/MICRO-LTR (0-.5 MICRON BAND)	0.000	0.000	0.000	1.510	0.300	0.000	0.000	0.000	0.000	0.000	0.000
PARTICLES/MICRO-LTR (.5-1 MICRON BAND)	0.000	0.000	0.000	2.020	2.530	0.000	.503	1.010	.126	0.000	0.000
PARTICLES/MICRO-LTR (1-2. MICRON BAND)	37.400	53.900	21.200	44.500	45.300	28.300	36.100	52.700	53.500	38.200	84.200
PARTICLES/MICRO-LTR (2-4. MICRON BAND)	73.600	71.900	42.100	42.100	82.200	44.100	62.500	101.000	94.400	63.300	87.100
PARTICLES/MICRO-LTR (4-8. MICRON BAND)	23.700	30.100	13.400	16.400	26.500	20.000	22.500	33.100	37.400	24.500.	28.800
PARTICLES/MICRO-LTR (8-16 MICRON BAND)	5.800	11.100	2.270	4.040	4.530	5.800	4.780	7.560	9.070	5.800	10.300

LOCATION-BOAT	BENDIX FLIGHT TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
NORFOLK 2 SURFACE	3406039 RUN 3	1037	17	504	-0	-0	-0	-0	948	1149

TIME (EDT), HOURS	915	935	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION STATION	SN2 2	SN2A 2	SN2B 2	SN2C 2	SN2D 2	SN2E 2	SN2F 2	SN2G BUOY 13	SN2H BUOY 12	SN2I BUOY 10	SN2J BUOY 11
DEPTH METERS	3.50	3.50	3.50	3.50	3.50	3.50	3.50	6.00	5.50	6.10	5.20
SECCHI DEPTH METERS	.85	.89	1.02	.94	1.00	.94	1.06	1.10	.79	.89	.82
CHLOROPHYLL A MG/M3	2.52	2.75	3.23	3.43	1.65	2.85	2.68	2.68	3.82	1.75	2.73
CHLOROPHYLL B MG/M3	.23	.04	.51	.24	.49	.08	.16	.16	.12	.03	.12
CHLOROPHYLL C MG/M3	4.02	4.76	7.13	6.75	7.25	3.98	5.30	3.03	6.12	3.40	3.97
PHAEOPHYTINS A MG/M3	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
CAROTENOIDS MG/M3	.04	.04	.05	.06	.06	.07	.04	.06	.05	.05	.05
TURBIDITY MG/L	-0.00	-0.00	4.20	-0.00	-0.00	-0.00	3.60	-0.00	-0.00	-0.00	-0.00
TOTAL SOLIDS MG/L	13.19	11.90	9.30	11.08	8.80	10.04	9.13	10.12	17.72	12.24	11.56
INORGANIC SOLIDS MG/L	10.10	5.70	6.30	-0.00	-0.00	-0.00	5.90	-0.00	-0.00	-0.00	-0.00
TRANSMITTANCE PERCENT	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
WIND SPEED KNOTS	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
WIND DIRECTION DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
NORFOLK 2 SURFACE	3406039 RUN 3	1037	17	504	-0	-0	-0	-0	948	1149

TIME (EDT), HOURS	915	935	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SN2	SN2A	SN2B	SN2C	SN2D	SN2E	SN2F	SN2G	SN2H	SN2I	SN2J
STATION	2	2	2	2	2	2	2	BUOY 13	BUOY 12	BUOY 10	BUOY 11
CURRENT SPEED KNOTS	.19	.21	.21	.10	.12	.16	.35	.35	.41	.16	.58
CURRENT DIRECTION DEGREES	202	142	177	167	167	157	157	157	172	112	202
TIDE MIN. SINCE MHW	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0
TEMPERATURE DEGREES C	19.94	19.80	19.50	20.10	19.42	19.99	20.20	19.80	19.38	19.78	19.75
SALINITY PARTS/1000	17.560	17.630	17.570	17.560	17.570	17.610	17.640	17.720	17.140	17.050	17.220
DISSOLVED O2 MG/L	6.52	6.50	6.29	6.27	5.91	7.08	6.35	6.54	7.78	5.89	7.20
ACIDITY PH	7.70	7.75	7.74	7.70	7.80	7.74	7.74	7.74	7.98	7.91	7.99
INORGANIC NO2 MG/L	.0111	.0089	.0087	.0087	.0093	.0123	.0096	.0087	.0057	.0072	.0066
INORGANIC NO3 MG/L	.1308	.0728	.1477	.1015	.1149	.0983	.0978	.1904	.0951	.0916	.0812
INORGANIC PO4 MG/L	.1105	.0856	.0894	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
FLUORESCENCE MG/L	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
SOLUB. ORG. CARBON MG/L	-0.0	-0.0	4.0	-0.0	-0.0	-0.0	2.0	-0.0	-0.0	-0.0	-0.0
EXTINCTION (DECK) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
NORFOLK 2 SURFACE	3406039 RUN 3	1037	17	504	-0	-0	-0	-0	948	1149

TIME (EDT), HOURS	915	935	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SN2	SN2A	SN2B	SN2C	SN2D	SN2E	SN2F	SN2G	SN2H	SN2I	SN2J
STATION	2	2	2	2	2	2	2	BUOY 13	BUOY 12	BUOY 10	BUOY 11
EXTINCTION (SURF) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (.5 M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1.5M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (2. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT SPEED-1M KNOTS	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT DIR.-1M DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0
PARTICLES/MICRO-LTR (0-.5 MICRON BAND)	1.510	.503	0.000	0.000	.503	0.000	0.000	0.000	0.000	0.000	0.000
PARTICLES/MICRO-LTR (.5-1 MICRON BAND)	1.510	4.040	0.000	0.000	2.270	0.000	0.000	0.000	0.000	0.000	0.000
PARTICLES/MICRO-LTR (1-2. MICRON BAND)	63.800	65.800	31.300	36.400	53.100	16.400	27.800	37.400	41.300	34.400	28.500
PARTICLES/MICRO-LTR (2-4. MICRON BAND)	75.200	72.300	51.500	63.300	54.300	36.400	37.400	67.400	86.200	58.400	52.700
PARTICLES/MICRO-LTR (4-8. MICRON BAND)	29.800	20.200	15.900	19.700	16.400	13.400	12.100	26.300	31.300	25.500	18.700
PARTICLES/MICRO-LTR (8-16 MICRON BAND)	10.600	7.320	5.030	6.290	4.040	5.800	3.540	6.290	9.850	6.540	32.800

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-1 IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 275 TIMES						
NORFOLK 3 SURFACE	806036 RUN 3	1037	1353	509	-0	-0	-0	-0	948	1149					
TIME (EDT), HOURS		915	935	955	1015	1035	1055	1115	1135	1155	1215	1235			
SAMPLE DESIGNATION STATION		SN3 3	SN3A 3	SN3B 3	SN3C 3	SN3D 3	SN3E 3	SN3F 3	SN3G BUOY 15	SN3H BUOY 14	SN3I FL 17	SN3J BUOY 17			
DEPTH METERS		4.12	4.12	4.12	4.12	4.12	4.12	4.12	11.90	14.80	10.00	11.60			
SECCHI DEPTH METERS		.84	.85	.83	1.00	1.00	1.10	1.11	1.30	.93	1.10	1.13			
CHLOROPHYLL A MG/M3		1.31	1.39	2.28	3.20	1.95	2.08	2.37	2.97	2.90	2.37	2.68			
CHLOROPHYLL B MG/M3		.20	.25	.21	.12	.34	.26	.22	.11	.11	.30	.22			
CHLOROPHYLL C MG/M3		2.96	3.28	2.57	3.53	4.62	4.02	4.13	3.73	3.27	3.88	5.32			
PHAEOPHYTINS A MG/M3		0.00	0.00	0.00	0.00	-10.00	0.00	0.00	0.00	0.00	0.00	0.00			
CAROTENOIDS MG/M3		.05	.06	.07	.09	.08	.08	.07	.07	.07	.08	.07			
TURBIDITY MG/L		-0.00	-0.00	4.30	-0.00	-0.00	-0.00	4.00	-0.00	-0.00	-0.00	-0.00			
TOTAL SOLIDS MG/L		14.34	10.17	11.52	8.28	12.00	10.12	9.67	8.60	21.52	9.04	10.96			
INORGANIC SOLIDS MG/L		6.77	7.33	4.03	-0.00	-0.00	-0.00	6.91	-0.00	-0.00	-0.00	-0.00			
TRANSMITTANCE PERCENT		-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00			
WIND SPEED KNOTS		-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0			
WIND DIRECTION DEGREES		-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0			

LOCATION-BOAT	BENDIX FLIGHT TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1474-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES						
NORFOLK 3 SURFACE	806036 RUN 3	1037	1353	509	-0	-0	-0	-0	948	1149					
TIME (EDT), HOURS		915	935	955	1015	1035	1055	1115	1135	1155	1215	1235			
SAMPLE DESIGNATION STATION		SN3 3	SN3A 3	SN3B 3	SN3C 3	SN3D 3	SN3E 3	SN3F 3	SN3G BUOY 15	SN3H BUOY 14	SN3I FL 17	SN3J BUOY 17			
CURRENT SPEED KNOTS		.43	.37	.31	.54	.72	.54	.54	.43	.43	.27	.54			
CURRENT DIRECTION DEGREES		180	180	180	180	180	180	180	180	180	180	180			
TIDE MIN. SINCE MHW		-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0			
TEMPERATURE DEGREES C		20.20	20.20	20.30	20.20	20.50	20.60	20.50	20.20	19.80	20.50	20.20			
SALINITY PARTS/1000		17.120	17.090	16.940	17.410	16.660	16.830	17.040	17.610	17.440	17.600	17.650			
DISSOLVED O2 MG/L		6.44	5.88	6.14	7.01	5.42	7.07	5.99	6.37	7.35	6.48	6.37			
ACIDITY PH		7.47	7.48	7.44	7.58	7.42	7.44	7.49	7.61	7.58	7.63	7.51			
INORGANIC NO2 MG/L		.0093	.0093	.0078	.0093	.0105	.0123	.0111	.0096	.0078	.0105	.0087			
INORGANIC NO3 MG/L		.1036	.1567	.1525	.1425	.1007	.0695	.0623	.1583	.0953	.1499	.1403			
INORGANIC PO4 MG/L		.2241	.2428	.3004	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000			
FLUORESCENCE MG/L		-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00			
SOLUB. ORG. CARBON MG/L		-0.0	-0.0	5.0	-0.0	-0.0	-0.0	4.0	-0.0	-0.0	-0.0	-0.0			
EXTINCTION (DECK) MIC.-AMP/FT-CAND.		-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00			

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES						
NORFOLK 3 SURFACE	806036 RUN 3	1037	1353	509	-0	-0	-0	-0	948	1149					
TIME (EDT), HOURS		915	935	955	1015	1035	1055	1115	1135	1155	1215	1235			
SAMPLE DESIGNATION		SN3	SN3A	SN3B	SN3C	SN3D	SN3E	SN3F	SN3G	SN3H	SN3I	SN3J			
STATION		3	3	3	3	3	3	3	BUOY 15	BUOY 14	FL 17	BUOY 17			
EXTINCTION (SURF) MIC.-AMP/FT-CAND.		-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00			
EXTINCTION (.5 M) MIC.-AMP/FT-CAND.		-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00			
EXTINCTION (1. M) MIC.-AMP/FT-CAND.		-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00			
EXTINCTION (1.5M) MIC.-AMP/FT-CAND.		-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00			
EXTINCTION (2. M) MIC.-AMP/FT-CAND.		-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00			
CURRENT SPEED-1M KNOTS		-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00			
CURRENT DIR.-1M DEGREES		-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0			
PARTICLES/MICRO-LTR (0-.5 MICRON BAND)		0.000	0.000	0.000	0.000	.253	0.000	0.000	.253	0.000	0.000	0.000			
PARTICLES/MICRO-LTR (.5-1 MICRON BAND)		0.000	0.000	0.000	2.530	3.790	1.770	0.000	.756	0.000	1.010	2.270			
PARTICLES/MICRO-LTR (1-2. MICRON BAND)		60.100	18.900	40.800	41.300	59.700	60.500	50.700	36.100	47.400	35.400	31.600			
PARTICLES/MICRO-LTR (2-4. MICRON BAND)		124.000	31.100	85.000	87.100	131.000	119.000	110.000	76.400	90.300	71.100	77.200			
PARTICLES/MICRO-LTR (4-8. MICRON BAND)		43.300	14.400	35.400	28.500	40.800	41.300	32.400	25.200	35.900	23.200	26.300			
PARTICLES/MICRO-LTR (8-16 MICRON BAND)		14.200	3.540	10.100	6.290	11.400	12.100	8.050	6.780	10.500	7.320	7.560			

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
HOPEWELLSI SURFACE	3415049 RUN 6	1113	782	507	6741313	1115	1491	463	1036	-0

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION STATION	SH1B BUOY R106	SH1C BUOY R106	SH1D BUOY R106	SH1E BUOY R106	SH1F BUOY R106	SH1G BUOY R106	SH1H BUOY R106	SH1I BUOY RN96	SH1J BUOY RN94
DEPTH METERS	8.50	8.50	8.50	8.50	7.90	7.90	7.30	9.20	8.20
SECCHI DEPTH METERS	.42	.42	.43	.47	.49	.41	.37	.39	.41
CHLOROPHYLL A MG/M3	13.67	17.41	18.85	16.54	17.46	15.61	15.78	19.50	19.50
CHLOROPHYLL B MG/M3	3.60	3.02	1.38	.10	1.75	.38	4.09	.52	.45
CHLOROPHYLL C MG/M3	8.15	10.47	3.99	1.57	6.29	2.55	.55	4.70	5.79
PHAEOPHYTINS A MG/M3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAROTENOIDS MG/M3	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
TURBIDITY MG/L	-0.00	18.00	-0.00	-0.00	17.00	-0.00	-0.00	-0.00	-0.00
TOTAL SOLIDS MG/L	34.40	24.60	29.20	23.80	28.20	31.80	31.60	34.40	47.60
INORGANIC SOLIDS MG/L	26.60	22.60	20.60	18.40	21.60	24.60	26.40	34.00	39.20
TRANSMITTANCE PERCENT	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
WIND SPEED KNOTS	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
WIND DIRECTION DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL.	LANDSAT-1 IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES			
HOPEWELLS1 SURFACE	3415049 RUN 6	1113	782	507	6741313	1115	1491	463	1036	-0		

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SH1B	SH1C	SH1D	SH1E	SH1F	SH1G	SH1H	SH1I	SH1J
STATION	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R100	BJOY RN96	BJOY RN94
CURRENT SPEED KNOTS	.42	.32	.62	.80	.99	.80	1.50	1.80	1.50
CURRENT DIRECTION DEGREES	190	265	190	210	195	250	280	265	270
TIDE MIN. SINCE MHW	5	25	45	65	85	105	125	145	165
TEMPERATURE DEGREES C	22.50	22.50	22.40	22.60	22.60	22.80	22.40	22.50	22.60
SALINITY PARTS/1000	.116	.087	.104	.096	.097	.106	.094	.082	.082
DISSOLVED O2 MG/L	6.17	6.05	5.99	6.09	5.89	5.79	5.69	5.89	6.23
ACIDITY PH	6.90	6.90	6.00	5.50	5.50	5.70	5.60	5.40	5.70
INORGANIC NO2 MG/L	3.2700	2.9700	3.1200	2.8700	2.8600	2.8800	3.0800	2.9400	3.1200
INORGANIC NO3 MG/L	23.6500	20.1600	23.8800	23.4700	21.7300	22.2700	22.0300	22.5700	23.1800
INORGANIC PO4 MG/L	.3300	.2600	.1900	.6300	.2200	.0700	.0700	0.0000	0.0000
FLUORESCENCE MG/L	17.72	17.22	12.32	12.66	12.79	12.41	10.63	15.20	14.31
SOLUB. ORG. CARBON MG/L	-0.0	6.0	-0.0	-0.0	6.0	-0.0	-0.0	-0.0	-0.0
EXTINCTION (DECK) MIC.-AMP/FT-CAND.	12.20	12.55	12.80	13.75	14.50	15.00	15.00	15.50	15.50

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
HOPEWELLSI SURFACE	3415049 RUN 6	1113	782	507	6741313	1115	1491	463	1336	-0

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SH1B	SH1C	SH1D	SH1E	SH1F	SH1G	SH1H	SH1I	SH1J
STATION	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R100	BUOY RN96	BUOY RN94
EXTINCTION (SURF) MIC.-AMP/FT-CAND.	2800.00	9200.00	10000.00	9800.00	8800.00	7800.00	10000.00	10000.00	10000.00
EXTINCTION (.5 M) MIC.-AMP/FT-CAND.	800.00	1600.00	2080.00	2320.00	2000.00	2200.00	2400.00	1400.00	1600.00
EXTINCTION (1. M) MIC.-AMP/FT-CAND.	205.00	300.00	340.00	350.00	250.00	250.00	400.00	200.00	150.00
EXTINCTION (1.5M) MIC.-AMP/FT-CAND.	12.00	20.00	20.00	12.00	10.00	15.00	20.00	4.50	6.50
EXTINCTION (2. M) MIC.-AMP/FT-CAND.	.50	3.50	2.50	2.20	1.70	1.50	1.00	.50	1.00
CURRENT SPEED-1M KNOTS	.24	.22	.80	.86	1.05	1.00	1.60	1.60	1.60
CURRENT DIR.-1M DEGREES	200	350	220	210	210	240	300	270	265
PARTICLES/MICRO-LTR (0-.5 MICRON BAND)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (.5-1 MICRON BAND)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (1-2. MICRON BAND)	72.000	72.000	75.000	70.000	77.000	67.000	60.000	75.000	50.000
PARTICLES/MICRO-LTR (2-4. MICRON BAND)	98.000	91.000	110.000	92.000	132.000	109.000	104.000	91.000	83.000
PARTICLES/MICRO-LTR (4-8. MICRON BAND)	32.000	32.000	35.000	29.000	42.000	35.000	36.000	31.000	28.000
PARTICLES/MICRO-LTR (8-16 MICRON BAND)	7.000	10.000	12.000	8.000	15.000	9.000	8.000	9.000	9.000

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1574-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
HOPEWELLD1	3415049	1113	782	507	6741313	1115	1491	463	1036	-0
DEPTH	RUN 6									

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	DH1B	DH1C	DH1D	DH1E	DH1F	DH1G	DH1H	DH1I	DH1J
STATION	BUOY R106	BUOY R106	BUOY R106	BUOY R105	BUOY R106	BUOY R106	BUOY R100	BUOY RV96	BUOY RN94
DEPTH METERS	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
SECCHI DEPTH METERS	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CHLOROPHYLL A MG/M3	-0.00	14.29	16.82	17.54	17.92	16.05	-0.00	20.84	21.70
CHLOROPHYLL B MG/M3	-0.00	1.98	1.43	1.20	1.63	1.50	-0.00	1.54	.99
CHLOROPHYLL C MG/M3	-0.00	8.97	5.98	2.54	5.53	3.41	-0.00	4.97	2.71
PHAEOPHYTINS A MG/M3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAROTENOIDS MG/M3	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
TURBIDITY MG/L	-0.00	18.00	-0.00	-0.00	20.00	-0.00	-0.00	-0.00	-0.00
TOTAL SOLIDS MG/L	31.80	26.80	28.20	30.20	29.00	35.20	28.20	40.60	45.00
INORGANIC SOLIDS MG/L	25.80	23.40	20.80	22.00	23.80	24.00	21.00	35.20	35.60
TRANSMITTANCE PERCENT	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
WIND SPEED KNOTS	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
WIND DIRECTION DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0

BENDIX FLIGHT 92 LANDSAT-I IMAGE 1674-15131 WALLOPS FLIGHT 276

LOCATION-BOAT	TAPE	TIME	LINE	COL	TAPE	TIME	LINE	COL	TIMES	
HOPEWELL01	3415049	1113	782	507	6741313	1115	1491	463	1036	-0
DEPTH	RUN 6									

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	DH1E	DH1C	DH1D	DH1E	DH1F	DH1G	DH1H	DH1I	DH1J
STATION	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R100	BUOY RN96	BUOY RN94
CURRENT SPEED KNOTS	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT DIRECTION DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0
TIDE MIN. SINCE MHW	5	25	45	65	85	105	125	145	165
TEMPERATURE DEGREES C	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
SALINITY PARTS/1000	.087	.106	.087	.085	.087	.096	.094	.089	.082
DISSOLVED O2 MG/L	6.05	5.85	6.19	6.19	5.59	5.79	5.85	6.09	5.93
ACIDITY PH	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
INORGANIC NO2 MG/L	3.0600	3.1100	3.3500	3.0300	2.9300	2.7500	2.9500	3.0000	3.1900
INORGANIC NO3 MG/L	25.7100	23.2300	24.0100	21.9500	21.7400	23.1100	23.8000	20.5900	20.4800
INORGANIC PO4 MG/L	.2200	.1900	.5300	.2700	.1500	.0900	.0600	0.0000	.1000
FLUORESCENCE MG/L	-0.00	13.42	13.93	12.79	13.67	14.94	-0.00	15.57	16.20
SOLUB. ORG. CARBON MG/L	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
EXTINCTION (DECK) MIC.-AMP/FT-CAND.	-0.00	4.00	-0.00	-0.00	5.00	-0.00	-0.00	-0.00	-0.00

BENDIX FLIGHT 92 LANDSAT-I IMAGE 1674-15131 WALLOPS FLIGHT 276

LOCATION-BOAT	TAPE	TIME	LINE	COL	TAPE	TIME	LINE	COL	TIMES	
HOPEWELLD1	3415049	1113	782	507	6741313	1115	1491	463	1036	-0
DEPTH	RUN 6									

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	DH1B	DH1C	DH1D	DH1E	DH1F	DH1G	DH1H	DH1I	DH1J
STATION	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R106	BUOY R100	BJOY RN96	BJOY RN94
EXTINCTION (SURF) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (.5 M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1.5M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (2. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT SPEED-1M KNOTS	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT DIR.-1M DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0
PARTICLES/MICRO-LTR (0-.5 MICRON BAND)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (.5-1 MICRON BAND)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (1-2. MICRON BAND)	66.000	63.000	53.000	71.000	87.000	76.000	69.000	47.000	30.000
PARTICLES/MICRO-LTR (2-4. MICRON BAND)	103.000	98.000	76.000	117.000	156.000	141.000	119.000	79.000	44.000
PARTICLES/MICRO-LTR (4-8. MICRON BAND)	35.000	32.000	28.000	37.000	56.000	43.000	43.000	29.000	12.000
PARTICLES/MICRO-LTR (8-16 MICRON BAND)	11.000	7.000	8.000	8.000	15.000	11.000	13.000	7.000	4.000

LOCATION-BOAT	BENDIX FLIGHT TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
HOPEWELL 2 SURFACE	3415049 RUN 6	1113	202	346	6741313	1115	1516	398	1040	-0

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SH2B	SH2C	SH2D	SH2E	SH2F	SH2G	SH2H	SH2I	SH2J
STATION	BOY RN116BOY	RN116BOY	RN116BOY	RN116BOY	RN116BOY	RN116BUOY	C117BUOY	C113BOY	RN112
DEPTH METERS	7.60	7.60	7.60	7.60	7.60	7.60	-0.00	-0.00	-0.00
SECCHI DEPTH METERS	.38	.44	.47	.42	.41	.40	.50	.39	.38
CHLOROPHYLL A MG/M3	14.40	15.01	13.13	11.95	2.05	13.09	13.58	10.26	11.51
CHLOROPHYLL B MG/M3	1.19	.64	.66	1.12	.60	.86	3.35	.25	2.08
CHLOROPHYLL C MG/M3	2.81	4.85	.56	3.14	2.64	3.52	9.44	2.49	2.71
PHAEOPHYTINS A MG/M3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAROTENOIDS MG/M3	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
TURBIDITY MG/L	20.00	-0.00	-0.00	-0.00	19.00	-0.00	-0.00	-0.00	-0.00
TOTAL SOLIDS MG/L	27.00	27.00	20.60	26.00	28.60	24.00	28.80	23.00	40.80
INORGANIC SOLIDS MG/L	22.40	19.00	13.40	21.60	20.40	23.20	20.40	17.40	34.20
TRANSMITTANCE PERCENT	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
WIND SPEED KNOTS	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
WIND DIRECTION DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
HOPEWELL 2 SURFACE	3415049 RUN 6	1113	202	346	6741313	1115	1516	398	1040	-0

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SH2B	SH2C	SH2D	SH2E	SH2F	SH2G	SH2H	SH2I	SH2J
STATION	BOY RN116BOY	RN116BOY	RN116BOY	RN116BOY	RN116BOY	RN116BUOY	C1178JJY	C113BOY	RN112
CURRENT SPEED KNOTS	.45	.50	.60	.45	.80	1.25	1.00	1.00	1.40
CURRENT DIRECTION DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0
TIDE MIN. SINCE MHW	-15	5	25	45	65	85	105	125	145
TEMPERATURE DEGREES C	22.80	22.80	22.80	22.80	22.90	23.00	23.00	23.20	23.20
SALINITY PARTS/1000	.104	.106	.108	.089	.097	.099	.099	.097	.097
DISSOLVED O2 MG/L	5.55	5.01	4.97	5.71	5.25	5.89	6.01	6.09	5.99
ACIDITY PH	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
INORGANIC NO2 MG/L	3.0600	2.9100	2.8900	2.6000	2.8700	2.5500	2.7300	2.7500	2.2800
INORGANIC NO3 MG/L	22.0500	22.5500	21.2500	21.0100	21.0500	20.3600	22.3300	22.8400	23.7500
INORGANIC PO4 MG/L	.1300	.0900	.0800	.1100	.0700	.0700	.0700	.1400	.0400
FLUORESCENCE MG/L	11.90	10.38	9.12	7.85	2.07	12.41	10.63	8.10	10.89
SOLUB. ORG. CARBON MG/L	5.0	-0.0	-0.0	-0.0	4.0	-0.0	-0.0	-0.0	-0.0
EXTINCTION (DECK) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00

BENDIX FLIGHT 92 LANDSAT-I IMAGE 1674-15131 WALLOPS FLIGHT 276

LOCATION-BOAT	TAPE	TIME	LINE	COL	TAPE	TIME	LINE	COL		TIMES	
HOPEWELL 2	3415049	1113	202	346	6741313	1115	1516	398		1040	-0
SURFACE	RUN 6										

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SH2B	SH2C	SH2D	SH2E	SH2F	SH2G	SH2H	SH2I	SH2J
STATION	BOY RN116	BOY RN116	BOY RN116	BOY RN116	BOY RN116	BOY RN116	BUOY C117	BUOY C113	BOY RN112
EXTINCTION (SURF) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (.5 M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1.5M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (2. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT SPEED-1M KNOTS	.20	.62	.45	.58	.85	1.20	.93	.85	1.20
CURRENT DIR.-1M DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0
PARTICLES/MICRO-LTR (0-.5 MICRON BAND)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (.5-1 MICRON BAND)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (1-2. MICRON BAND)	57.000	90.000	87.000	86.000	67.000	63.000	83.000	83.000	61.000
PARTICLES/MICRO-LTR (2-4. MICRON BAND)	97.000	141.000	161.000	134.000	85.000	97.000	121.000	121.000	84.000
PARTICLES/MICRO-LTR (4-8. MICRON BAND)	34.000	46.000	50.000	46.000	28.000	32.000	33.000	25.000	27.000
PARTICLES/MICRO-LTR (8-16 MICRON BAND)	8.000	10.000	14.000	11.000	7.000	10.000	9.000	7.000	10.000

LOCATION-BOAT	BENDIX FLIGHT TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
HOPEWELL 3 SURFACE	3415049 RUN 6	1113	65	580	6741313	1115	1498	375	1040	-0

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SH3B	SH3C	SH3D	SH3E	SH3F	SH3G	SH3H	SH3I	SH3J
STATION	BOY RN120BOY	RN120BOY	RN120BOY	RN120BOY	RN120BOY	RN120BUOY	C119BUOY	C122	BUOY R6
DEPTH METERS	5.50	5.50	5.50	5.50	5.50	5.50	11.60	8.90	2.70
SECCHI DEPTH METERS	.48	.51	.54	.51	.48	.52	.44	.50	.55
CHLOROPHYLL A MG/M3	-0.00	6.49	7.90	5.79	9.19	7.78	6.56	8.73	9.69
CHLOROPHYLL B MG/M3	-0.00	.90	2.18	1.17	2.76	.39	1.39	1.88	.32
CHLOROPHYLL C MG/M3	-0.00	2.20	6.85	1.99	5.44	2.68	.23	3.90	1.84
PHAEOPHYTINS A MG/M3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAROTENOIDS MG/M3	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
TURBIDITY MG/L	18.00	-0.00	-0.00	-0.00	18.00	-0.00	-0.00	-0.00	-0.00
TOTAL SOLIDS MG/L	27.80	23.40	23.20	21.80	24.40	21.00	26.80	31.40	22.40
INORGANIC SOLIDS MG/L	26.40	17.40	18.20	18.60	21.40	-0.00	19.60	25.60	20.20
TRANSMITTANCE PERCENT	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
WIND SPEED KNOTS	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
WIND DIRECTION DEGREES	-0	-0	-0	-0	-0	-0	-0	-0	-0

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15121 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES			
HOPEWELL 3 SURFACE	3415049 RUN 6	1113	65	580	6741313	1115	1498	375	1040	-0		

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION	SH3B	SH3C	SH3D	SH3E	SH3F	SH3G	SH3H	SH3I	SH3J
STATION	BOY RN120BOY	RN120BOY	RN120BOY	RN120BOY	RN120BOY	RN120BUOY	C119BUOY	C122	BUOY R6
CURRENT SPEED KNOTS	.10	.18	.20	.48	.60	.60	.45	.76	.80
CURRENT DIRECTION DEGREES	230	280	300	310	230	348	260	350	190
TIDE MIN. SINCE MHW	-30	-10	10	30	50	70	90	110	130
TEMPERATURE DEGREES C	22.00	22.00	22.00	22.00	22.00	22.00	22.50	22.60	22.00
SALINITY PARTS/1000	.130	.120	.094	.099	.104	.078	.082	.080	.089
DISSOLVED O2 MG/L	6.31	5.65	5.49	5.73	5.75	6.19	6.61	6.35	6.91
ACIDITY PH	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
INORGANIC NO2 MG/L	2.2100	2.4800	2.5700	2.2900	2.2800	1.9100	1.8400	1.5200	1.3800
INORGANIC NO3 MG/L	21.5300	21.0200	21.8200	22.1200	21.5100	19.2400	18.4700	16.5900	14.8600
INORGANIC PO4 MG/L	.2200	.2200	.1900	.1500	.2200	.3000	.2600	.1300	.1700
FLUORESCENCE MG/L	-0.00	12.41	10.63	9.62	12.07	11.14	9.79	10.30	9.62
SOLUB. ORG. CARBON MG/L	4.0	-0.0	-0.0	-0.0	6.0	-0.0	-0.0	-0.0	-0.0
EXTINCTION (DECK) MIC.-AMP/FT-CAND.	0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
HOPEWELL 3 SURFACE	3415049 RUN 6	1113	65	580	6741313	1115	1498	375	1040	-0

TIME (EDT), HOURS	955	1015	1035	1055	1115	1135	1155	1215	1235
SAMPLE DESIGNATION STATION	SH3B BOY RN120BOY	SH3C RN120BOY	SH3D RN120BOY	SH3E RN120BOY	SH3F RN120BOY	SH3G RN120BUOY	SH3H C119BJOY	SH3I C122	SH3J BJOY R6
EXTINCTION (SURF) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (.5 M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1.5M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
EXTINCTION (2. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CURRENT SPEED-1M KNOTS	.25	.30	.20	.40	.62	.74	.50	.70	.66
CURRENT DIR.-1M DEGREES	250	300	328	315	320	340	280	360	180
PARTICLES/MICRO-LTR (0-.5 MICRON BAND)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (.5-1 MICRON BAND)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (1-2. MICRON BAND)	90.000	89.000	67.000	73.000	93.000	68.000	53.000	65.000	84.000
PARTICLES/MICRO-LTR (2-4. MICRON BAND)	168.000	138.000	92.000	121.000	139.000	91.000	94.000	103.000	149.000
PARTICLES/MICRO-LTR (4-8. MICRON BAND)	55.000	42.000	29.000	36.000	45.000	28.000	33.000	32.000	63.000
PARTICLES/MICRO-LTR (8-16 MICRON BAND)	14.000	10.000	6.000	8.000	12.000	5.000	8.000	9.000	16.000

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
HOGISLAND SURFACE	3408027 RUN 4	1054	401	421	6741314	1115	1517	557	1312	-0

TIME (EDT), HOURS	1045	1100	1114	1135
SAMPLE DESIGNATION STATION	SHIID A	SHIIE B	SHIIF C	SHIIG BUOY 38
DEPTH METERS	5.50	4.30	7.30	5.80
SECCHI DEPTH METERS	.38	.38	-0.00	-0.00
CHLOROPHYLL A MG/M3	2.00	3.00	6.00	4.00
CHLOROPHYLL B MG/M3	-0.00	-0.00	-0.00	-0.00
CHLOROPHYLL C MG/M3	-0.00	-0.00	-0.00	-0.00
PHAEOPHYTINS A MG/M3	0.00	0.00	0.00	0.00
CAROTENOIDS MG/M3	-0.00	-0.00	-0.00	-0.00
TURBIDITY MG/L	29.00	33.00	76.00	31.00
TOTAL SOLIDS MG/L	32.30	46.80	101.30	27.10
INORGANIC SOLIDS MG/L	4.00	34.80	83.80	20.50
TRANSMITTANCE PERCENT	-0.00	-0.00	-0.00	-0.00
WIND SPEED KNOTS	-0.0	-0.0	-0.0	-0.0
WIND DIRECTION DEGREES	-0	-0	-0	-0

LOCATION-BOAT	BENDIX FLIGHT TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
HOGISLAND SURFACE	3408027 RUN 4	1054	401	421	6741314	1115	1517	557	1012	-0

TIME (EDT), HOURS	1045	1100	1114	1135
SAMPLE DESIGNATION STATION	SHIID A	SHIIE B	SHIIF C	SHIIG BUOY 38
CURRENT SPEED KNOTS	-0.00	-0.00	-0.00	-0.00
CURRENT DIRECTION DEGREES	-0	-0	-0	-0
TIDE MIN. SINCE MHW	-0	-0	-0	-0
TEMPERATURE DEGREES C	-0.00	-0.00	-0.00	-0.00
SALINITY PARTS/1000	-0.000	-0.000	-0.000	-0.000
DISSOLVED O2 MG/L	-0.00	-0.00	-0.00	-0.00
ACIDITY PH	-0.00	-0.00	-0.00	-0.00
INORGANIC NO2 MG/L	-0.0000	-0.0000	-0.0000	-0.0000
INORGANIC NO3 MG/L	2.5000	2.4000	2.6000	2.5000
INORGANIC PO4 MG/L	.1000	.0900	.1000	.0900
FLUORESCENCE MG/L	-0.00	-0.00	-0.00	-0.00
SOLUB. ORG. CARBON MG/L	6.0	4.0	3.0	2.0
EXTINCTION (DECK) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
HOGISLAND SURFACE	3408027 RUN 4	1054	401	421	6741314	1115	1517	557	1012	-0

TIME (EDT), HOURS	1045	1100	1114	1135
SAMPLE DESIGNATION STATION	SHIID A	SHIIE B	SHIIF C	SHIIG BUOY 39
EXTINCTION (SURF) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00
EXTINCTION (.5 M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00
EXTINCTION (1.5M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00
EXTINCTION (2. M) MIC.-AMP/FT-CAND.	-0.00	-0.00	-0.00	-0.00
CURRENT SPEED-1M KNOTS	-0.00	-0.00	-0.00	-0.00
CURRENT DIR.-1M DEGREES	-0	-0	-0	-0
PARTICLES/MICRO-LTR (0-.5 MICRON BAND)	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (.5-1 MICRON BAND)	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (1-2. MICRON BAND)	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (2-4. MICRON BAND)	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (4-8. MICRON BAND)	-0.000	-0.000	-0.000	-0.000
PARTICLES/MICRO-LTR (8-16 MICRON BAND)	-0.000	-0.000	-0.000	-0.000

LOCATION-BOAT	BENDIX FLIGHT TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
LEE HALL SURFACE	-0	-0	-0	-0	6741314	1115	1523	729	-0	-0

TIME (EDT), HOURS	1230
SAMPLE DESIGNATION STATION	SLH1J
DEPTH METERS	2.60
SECCHI DEPTH METERS	1.52
CHLOROPHYLL A MG/M3	8.00
CHLOROPHYLL B MG/M3	-0.00
CHLOROPHYLL C MG/M3	-0.00
PHAEOPHYTINS A MG/M3	0.00
CAROTENOIDS MG/M3	-0.00
TURBIDITY MG/L	3.20
TOTAL SOLIDS MG/L	7.10
INORGANIC SOLIDS MG/L	1.30
TRANSMITTANCE PERCENT	-0.00
WIND SPEED KNOTS	-0.0
WIND DIRECTION DEGREES	-0

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
LEE HALL SURFACE	-0	-0	-0	-0	6741314	1115	1523	729	-0	-0

TIME (EDT), HOURS	1230
SAMPLE DESIGNATION STATION	SLH1J
CURRENT SPEED KNOTS	-0.00
CURRENT DIRECTION DEGREES	-0
TIDE MIN. SINCE MHW	-0
TEMPERATURE DEGREES C	-0.00
SALINITY PARTS/1000	-0.000
DISSOLVED O2 MG/L	-0.00
ACIDITY PH	-0.00
INORGANIC NO2 MG/L	-0.0000
INORGANIC NO3 MG/L	.1000
INORGANIC PO4 MG/L	.0200
FLUORESCENCE MG/L	-0.00
SOLUB. ORG. CARBON MG/L	1.3
EXTINCTION (DECK) MIC.-AMP/FT-CAND.	-0.00

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
LEE HALL SURFACE	-0	-0	-0	-0	6741314	1115	1523	729	-0	-0

TIME (EDT), HOURS	1230
SAMPLE DESIGNATION STATION	SLH1J
EXTINCTION (SURF) MIC.-AMP/FT-CAND.	-0.00
EXTINCTION (.5 M) MIC.-AMP/FT-CAND.	-0.00
EXTINCTION (1. M) MIC.-AMP/FT-CAND.	-0.00
EXTINCTION (1.5M) MIC.-AMP/FT-CAND.	-0.00
EXTINCTION (2. M) MIC.-AMP/FT-CAND.	-0.00
CURRENT SPEED-1M KNOTS	-0.00
CURRENT DIR.-1M DEGREES	-0
PARTICLES/MICRO-LTR (0-.5 MICRON BAND)	-0.000
PARTICLES/MICRO-LTR (.5-1 MICRON BAND)	-0.000
PARTICLES/MICRO-LTR (1-2. MICRON BAND)	-0.000
PARTICLES/MICRO-LTR (2-4. MICRON BAND)	-0.000
PARTICLES/MICRO-LTR (4-8. MICRON BAND)	-0.000
PARTICLES/MICRO-LTR (8-16 MICRON BAND)	-0.000

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
SUNKEN MDW SURFACE	3308037 RUN 6	1120	443	23	6741314	1115	1570	123	1018	-0

TIME (EDT), HOURS	1020
SAMPLE DESIGNATION STATION	SSM1C
DEPTH METERS	1.20
SECCHI DEPTH METERS	.46
CHLOROPHYLL A MG/M3	2.00
CHLOROPHYLL B MG/M3	-0.00
CHLOROPHYLL C MG/M3	-0.00
PHAEOPHYTINS A MG/M3	0.00
CAROTENOIDS MG/M3	-0.00
TURBIDITY MG/L	23.00
TOTAL SOLIDS MG/L	7.30
INORGANIC SOLIDS MG/L	2.00
TRANSMITTANCE PERCENT	-0.00
WIND SPEED KNOTS	-0.0
WIND DIRECTION DEGREES	-0

LOCATION-BOAT	BENDIX FLIGHT 92 TAPE	TIME	LINE	COL	LANDSAT-I IMAGE 1674-15131 TAPE	TIME	LINE	COL	WALLOPS FLIGHT 276 TIMES	
SUNKEN MDW SURFACE	3308037 RUN 6	1120	443	23	6741314	1115	1570	123	1018	-0

TIME (EDT), HOURS	1020
SAMPLE DESIGNATION STATION	SSM1C
CURRENT SPEED KNOTS	-0.00
CURRENT DIRECTION DEGREES	-0
TIDE MIN. SINCE MHW	-0
TEMPERATURE DEGREES C	-0.00
SALINITY PARTS/1000	-0.000
DISSOLVED O2 MG/L	-0.00
ACIDITY PH	-0.00
INORGANIC NO2 MG/L	-0.0000
INORGANIC NO3 MG/L	.1000
INORGANIC PO4 MG/L	.0600
FLUORESCENCE MG/L	-0.00
SOLUB. ORG. CARBON MG/L	8.0
EXTINCTION (DECK) MIC.-AMP/FT-CAND.	-0.00

	BENDIX FLIGHT 92				LANDSAT-1 IMAGE 1674-15131				WALLOPS FLIGHT 276	
LOCATION-BOAT	TAPE	TIME	LINE	COL	TAPE	TIME	LINE	COL	TIMES	
SUNKEN MDW	3308037	1120	443	23	6741314	1115	1570	123	1018	-0
SURFACE	RUN 6									

TIME (EDT), HOURS	1020
SAMPLE DESIGNATION	SSMIC
STATION	
EXTINCTION (SURF) MIC.-AMP/FT-CAND.	-0.00
EXTINCTION (.5 M) MIC.-AMP/FT-CAND.	-0.00
EXTINCTION (1. M) MIC.-AMP/FT-CAND.	-0.00
EXTINCTION (1.5M) MIC.-AMP/FT-CAND.	-0.00
EXTINCTION (2. M) MIC.-AMP/FT-CAND.	-0.00
CURRENT SPEED-1M KNOTS	-0.00
CURRENT DIR.-1M DEGREES	-0
PARTICLES/MICRO-LTR (0-.5 MICRON BAND)	-0.000
PARTICLES/MICRO-LTR (.5-1 MICRON BAND)	-0.000
PARTICLES/MICRO-LTR (1-2. MICRON BAND)	-0.000
PARTICLES/MICRO-LTR (2-4. MICRON BAND)	-0.000
PARTICLES/MICRO-LTR (4-8. MICRON BAND)	-0.000
PARTICLES/MICRO-LTR (8-16 MICRON BAND)	-0.000

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TABLE I.- FLIGHT TIMES FOR WALLOPS AIRCRAFT

(MOCS AND MSP)

Flight Line	Time EDT
1	0937 - 0940
2/1	0945 - 0948
3	0955 - 1008
4	1011 - 1018
5	1024 - 1030
6/1	1035 - 1036
7/1	1040 - 1042
8	1049 - 1053
9	1056 - 1100
6/2	1113 - 1114
7/2	1119 - 1120
10	1126 - 1130
2/2	1147 - 1150

TABLE II.- FLIGHT TIMES FOR BENDIX AIRCRAFT

(AIRBORNE M2S)

Run	Time, EDT	Run Time Min: Sec
1	8:30 - 8:40.10	2:10
2	10:23 - 10:24.55	1.55
3	10:35 - 10:40.00	5:00
4	10:45 - 10:54.30	9:30
5	11:00 - 11:01.45	1:45
6	11:12 - 11:33.00	12:00

TABLE III.- GROUND TRUTH SAMPLING FREQUENCY

AND REMOTE SENSING FLIGHTS

Ground Truth Data Collections	Water Sample Time Designation (1)	Approximate Remote Sensing Times		
		MOCS & MSP	M2S	LANDSAT
0915	(2)			
0935	A	X		
0955	B			
1015	C		X	
1035	D			
1055	E			
1115	F			X
1135	G		X	
1155	H	X		
1215	I			
1235	J			

(1) Water Sample Designation is, for example, SN1A where S - Surface; N - Norfolk; 1 - Boat 1; and A is time (0935 Hr)

(2) Extra Sample in anticipation of Bendix M2S fly-over

TABLE IV.- SPECTRAL RANGES AND BANDS FOR REMOTE SENSORS

Sensor	Range	Bands	
Multispectral Photography	Visible & Near IR	See Table VI	
MOCS	400 - 700 nm	20 bands, 15 nm wide (400-415, 415-430, etc.)	
M2S (Airborne)	380 - 1060 nm + Thermal	Band	Range
		1	380 - 440 nm
		2	440 - 490 nm
		3	495 - 535 nm
		4	540 - 580 nm
		5	580 - 620 nm
		6	620 - 660 nm
		7	660 - 700 nm
		8	700 - 740 nm
		9	760 - 860 nm
		10	970 - 1060 nm
		Thermal	8000 - 13,000 nm
MSS (LANDSAT-I)	500 - 1100 nm	Band 4	500 - 600 nm
		Band 5	600 - 700 nm
		Band 6	700 - 800 nm
		Band 7	800 - 1100 nm

TABLE V.- FLIGHT ALTITUDES, FIELDS OF VIEW,

AND RESOLUTION OF REMOTE SENSORS

Sensor	Altitude Kilometers	Field of View		Resolution, m
		Width, m	Length, m	
Multispectral Photo.	5.3	7300	7300	1.5 - 3
MOCS	5.3	1600	Continuous	10.6 X 21.4
M2S (Airborne)	2.4	6800	Continuous	7
MSS (LANDSAT-1)	700	185,000	175,000	70 - 100

*Standardized image format; data are continuous.

TABLE VI.- MULTISPECTRAL PHOTOGRAPHY SENSOR COMPLEMENT AND CAMERA SETTINGS

Camera	Focal Length (mm)	Filter	Film Format (mm)	Film Type[3]	Speed (Sec)	f Number
1. Hasselblad	40	5540 (green)[1]	70	2402 Black & White	1/250	4
2. Hasselblad	40	5250 (blue green)[1]	70	2402 Black & White	1/250	4
3. Hasselblad	40	12 (yellow)[2]	70	2402 Black & White	1/250	11
4. Hasselblad	40	89B (NIR)[2]	70	2424 Black & White	1/250	5.6

[1]Baird-atomic B-3 optical filter with central wavelength of 5540 and 5250 anstroms

[2]Kodak Wratten optical filter number

[3]Kodak film number

TABLE VII.- GROUND TRUTH MEASUREMENTS

Parameter
Wind Speed, knots
Wind Direction, degrees
Temperature, °C
Salinity, ppt
Dissolved O_2, mg/ℓ
pH
Secchi Depth, m
Chlorophyll a, mg/m^3
Chlorophyll b, mg/m^3
Chlorophyll c, mg/m^3
Inorganic PO_4, mg/ℓ
Inorganic NO_2, mg/ℓ
Inorganic NO_3, mg/ℓ
Phaeophytins a, µg/ℓ
Carotenoids, mg/m^3
Water Depth, m
Current Speed, knots
Current Direction, degrees
Transmittance, m
Total Susp. Solids, mg/ℓ
Total Inorg. s/s, mg/ℓ
Tidal Conditions†
Size Fractions, particles/ℓ
0.0-0.5 µ
0.5-1.0 µ
1.0-2.0 µ
2.0-4.0 µ
4.0-8.0 µ
8.0-16.0 µ
200 - 900 nm Scan
200 - 900 nm Acetone extract scan

†Hr and min after mean high water (MHW) or mean low water (MLW)

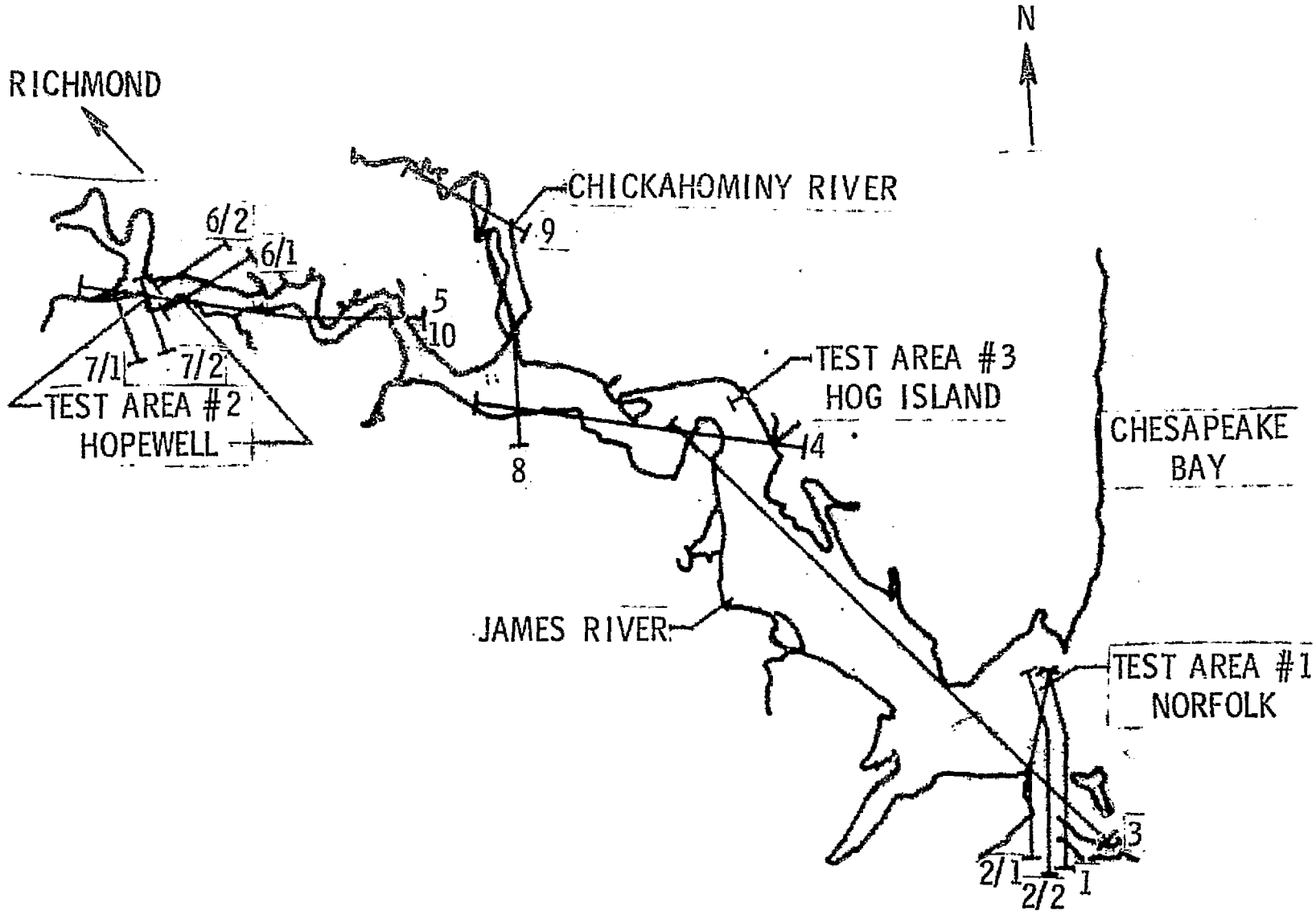


Figure 1.- Experimental area showin Wallops aircraft flight lines and ground truth test areas. (Sensors were MOCS and MSP).

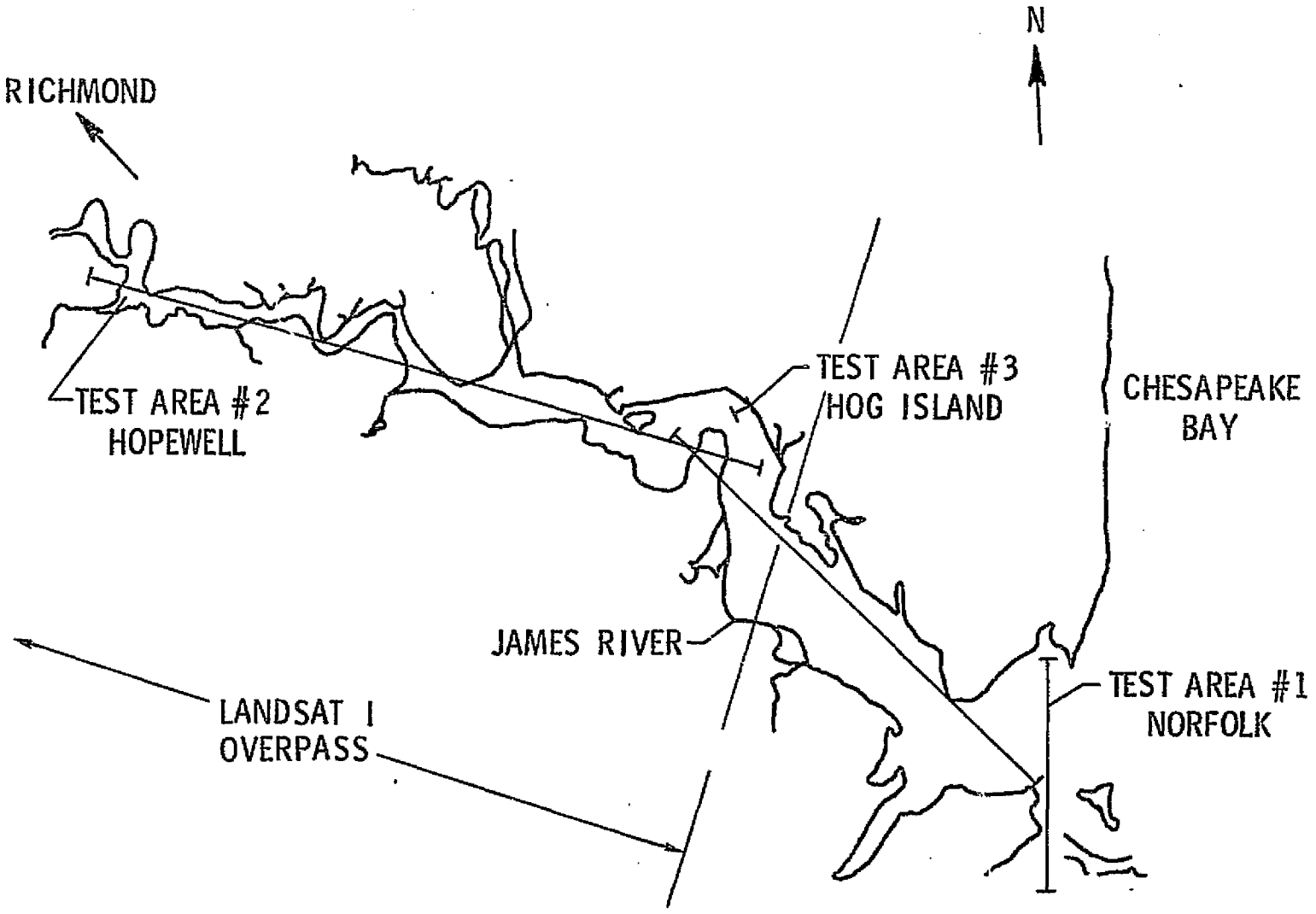


Figure 2.- Bendix aircraft flight lines and LANDSAT overpass.

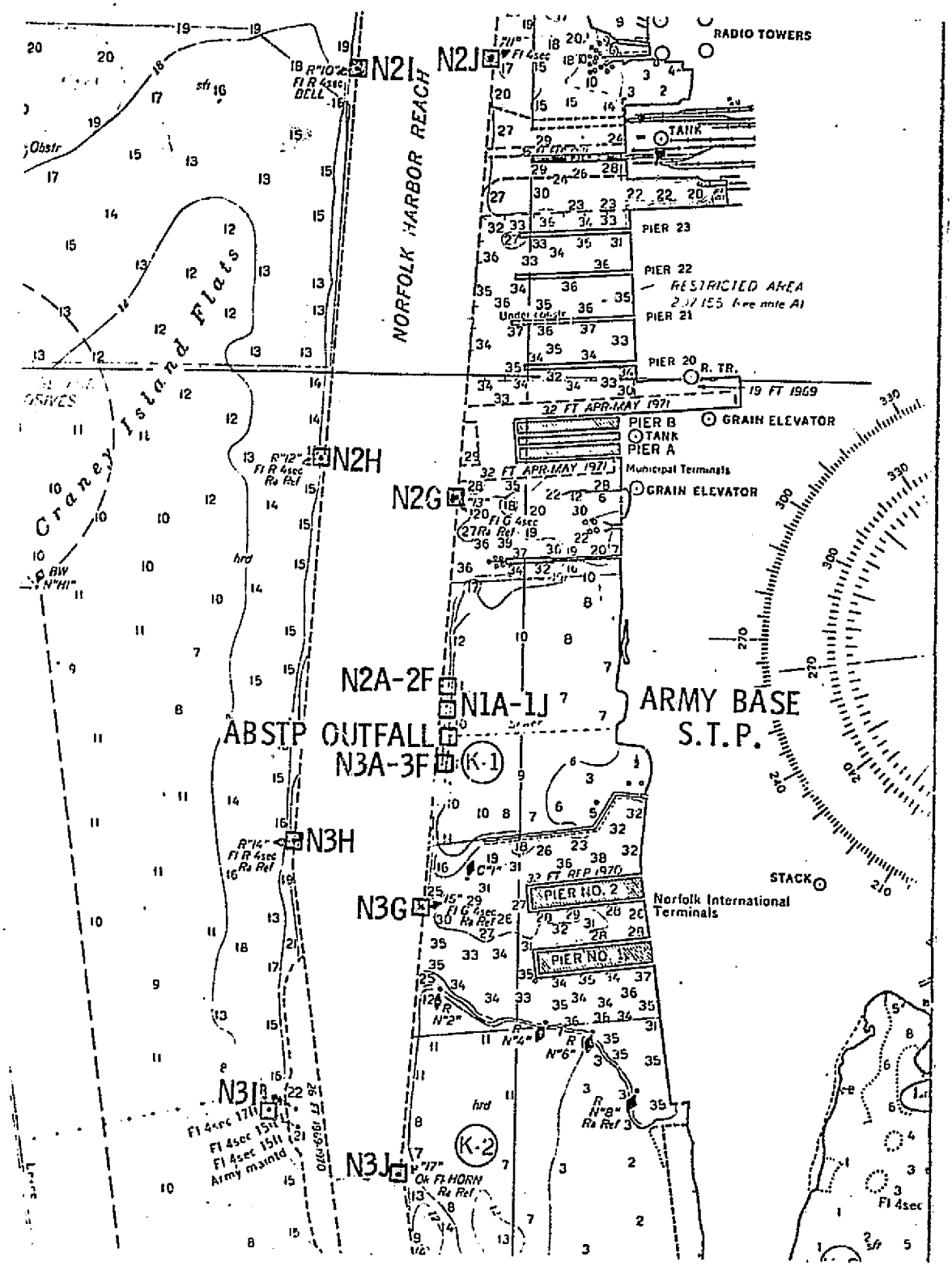


Figure 3.- Ground truth station locations and water samples.

(a) Norfolk area.

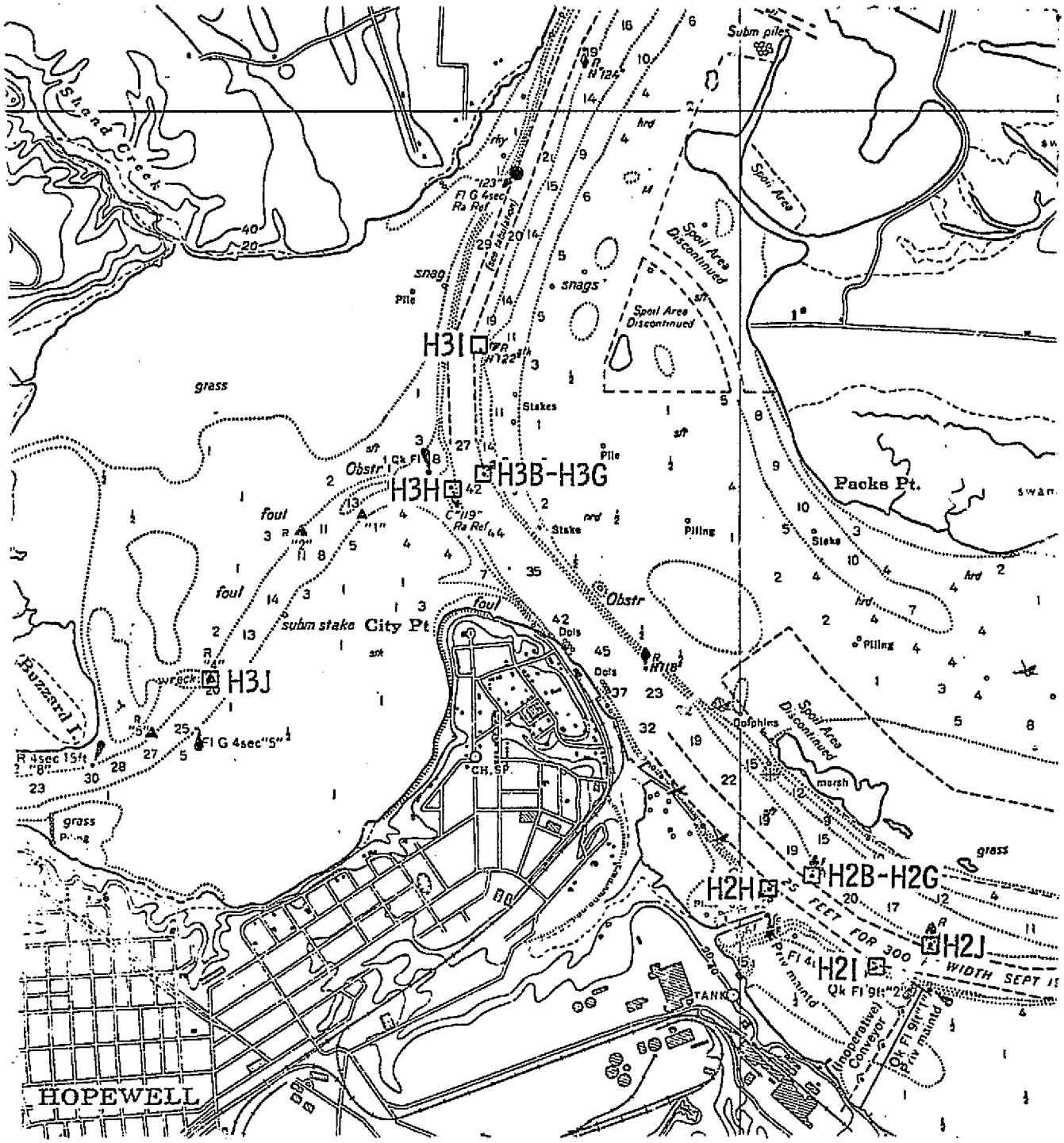


Figure 3.- Continued.

(b) Hopewell area - near City Point.

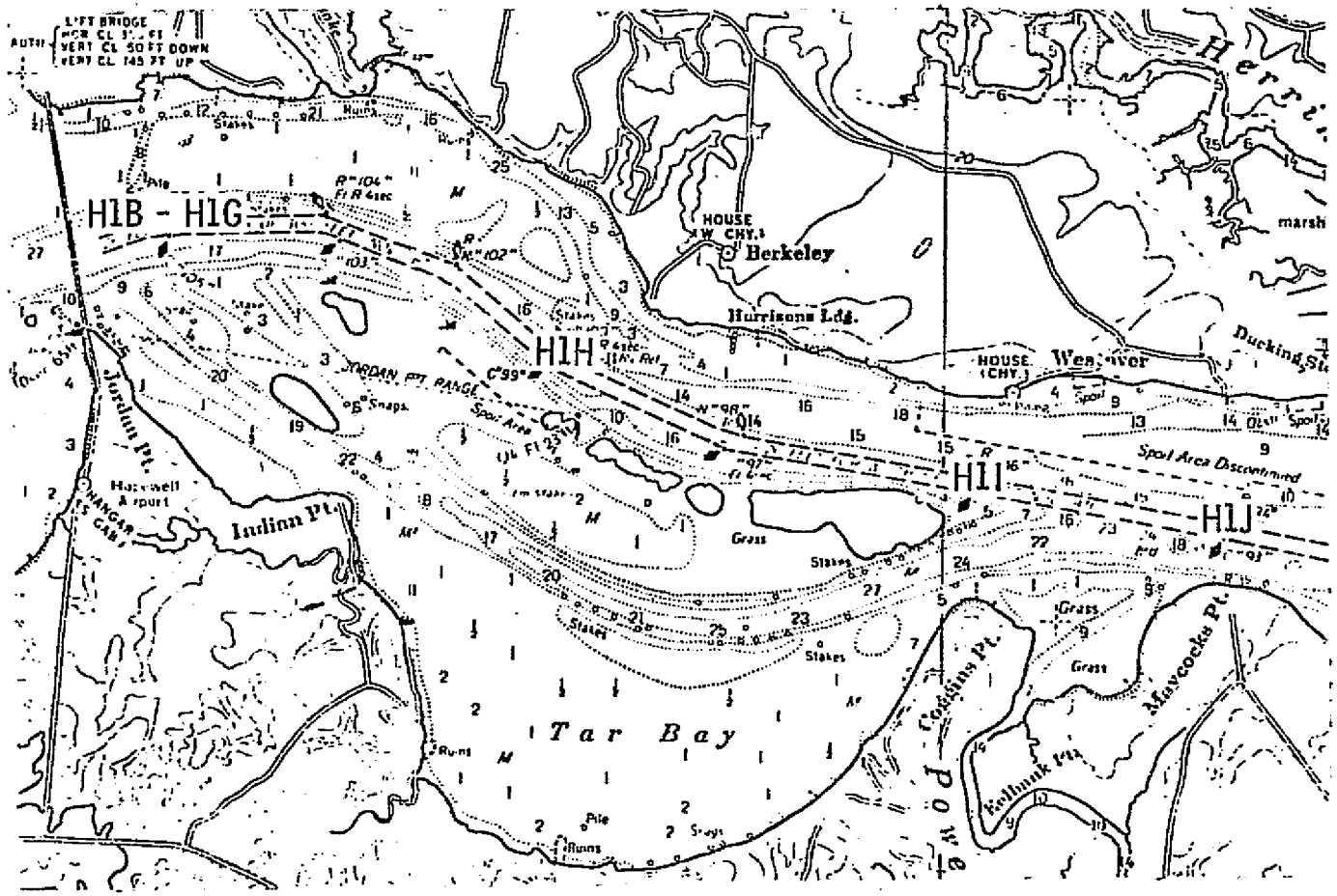


Figure 3.- Continued.

(c) Hopewell area - near Jordan Point.

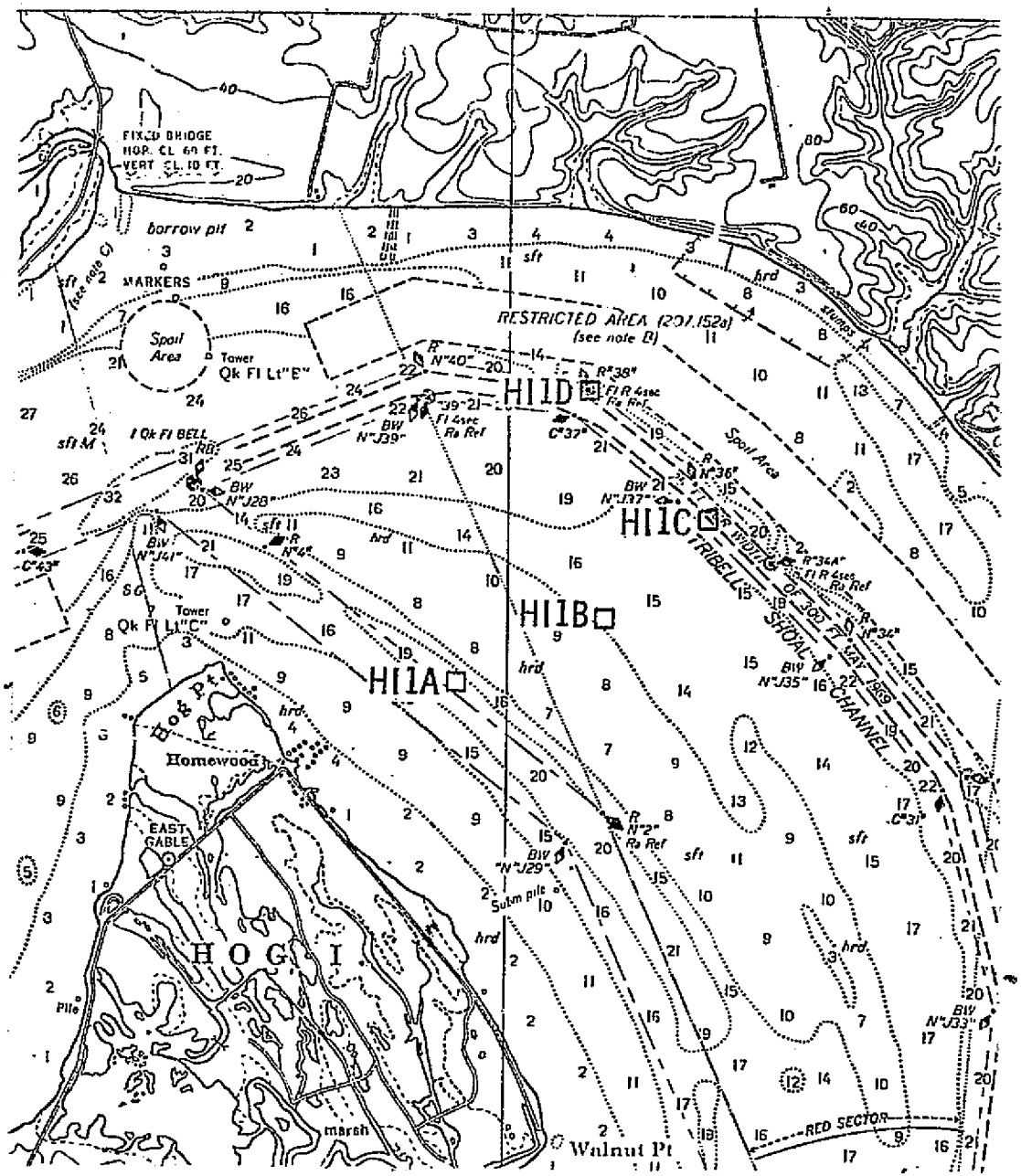


Figure 3.- Concluded.

(d) Hog Island area.

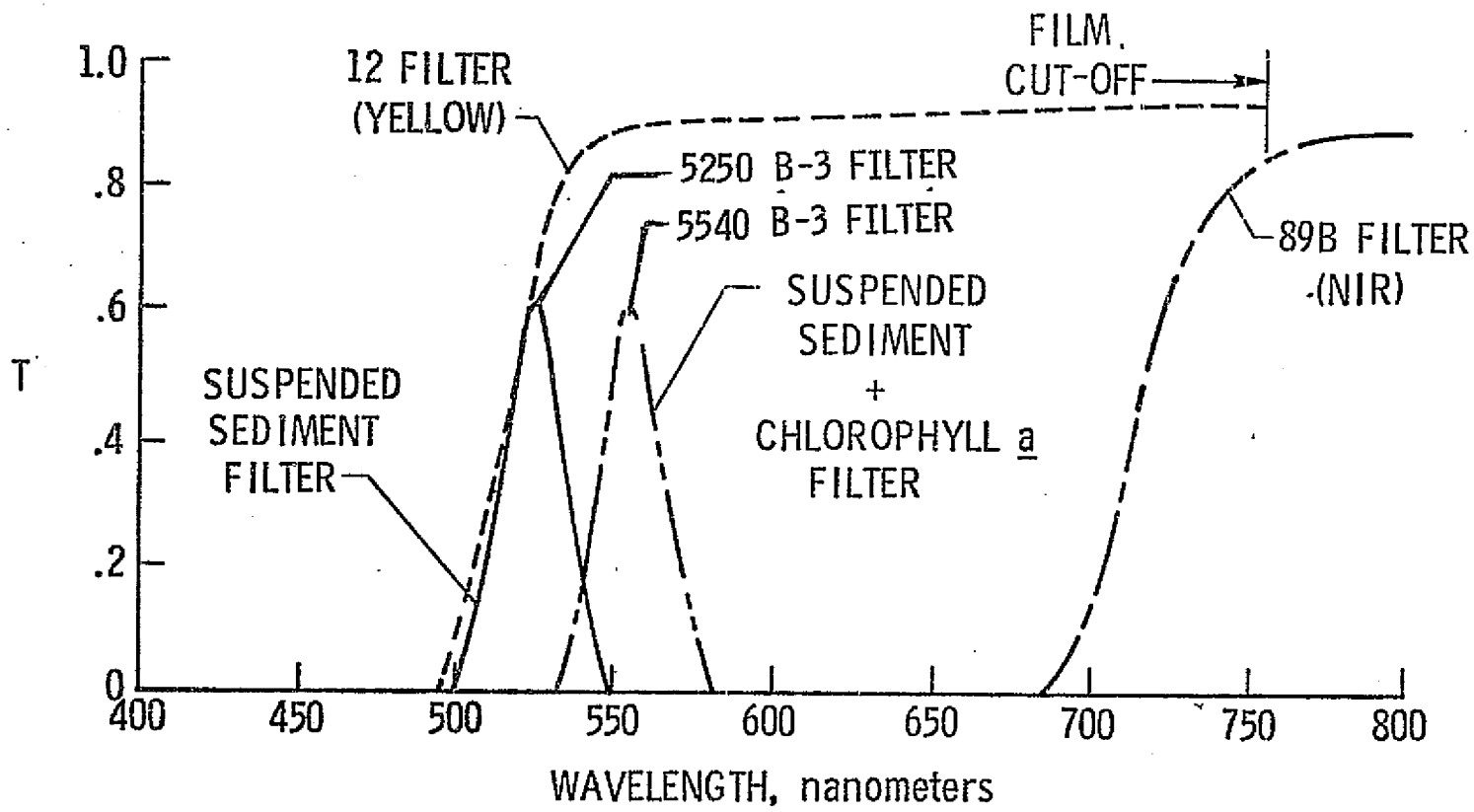
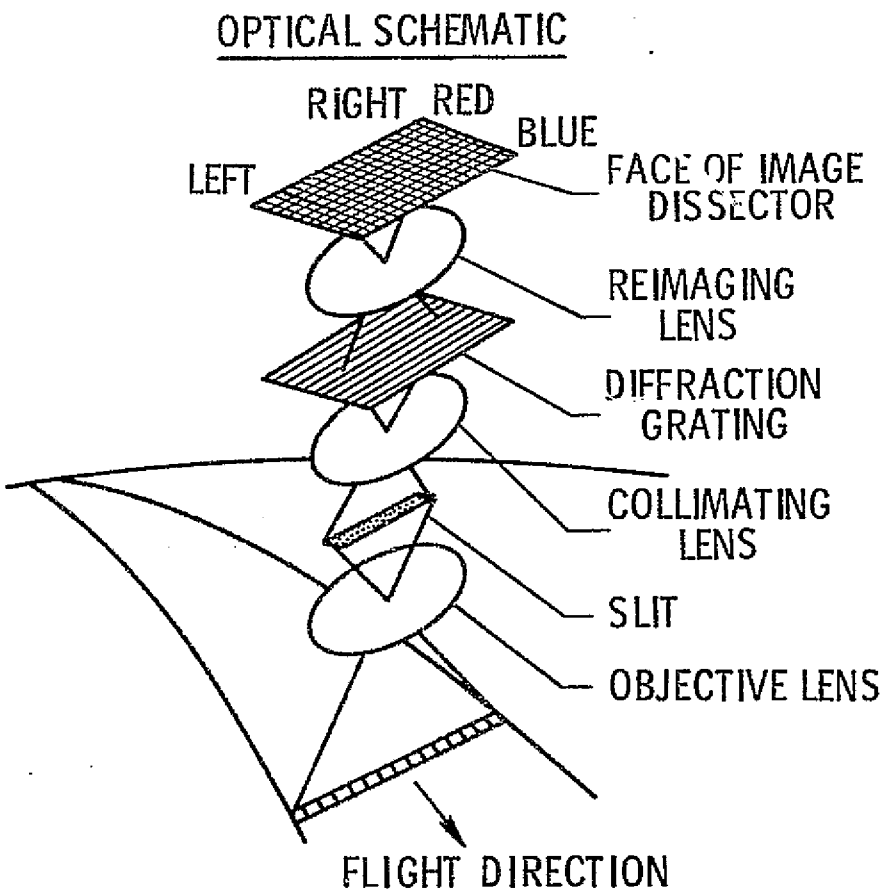


Figure 4. - The spectral variation of optical transmittance, T, for 5250 & 5540 B-3 Baird-Atomic and number 12 and 89B Wratten optical filters.



SPECIFICATIONS

400-700 nm SPECTRAL RANGE

15 nm SPECTRAL RESOLUTION

20 SPECTRAL BANDS

150 SPECTRA/ SWATH WIDTH

17.1° FIELD OF VIEW

22.5 pounds

7.5 watts

.35 cubic feet

Figure 5.- Optical schematic and specifications of MOCS.

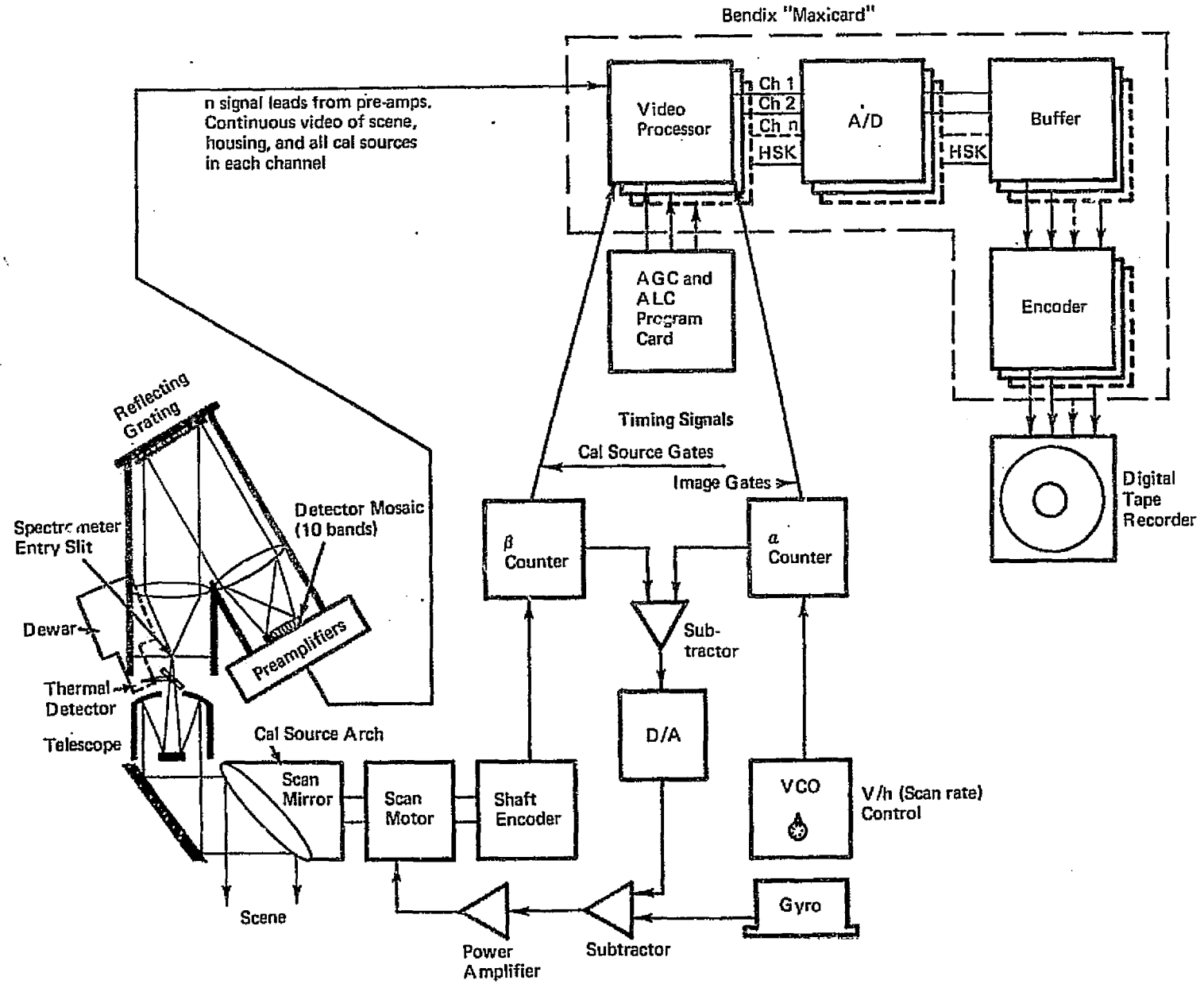
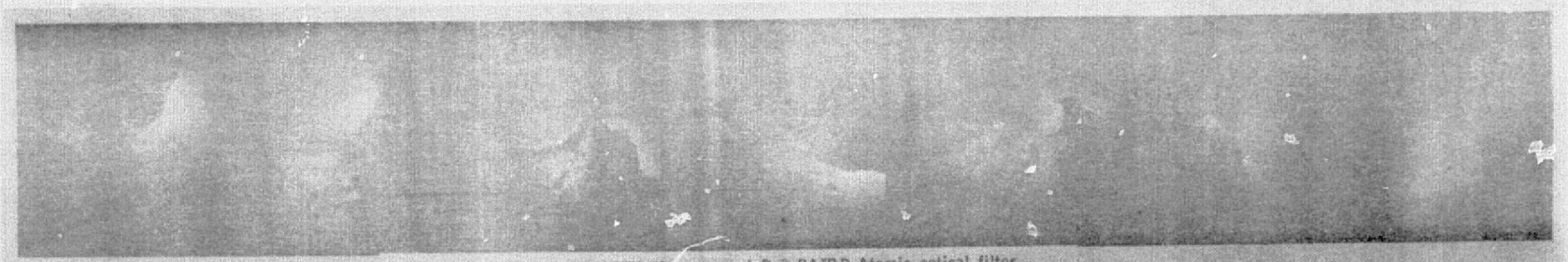


Figure 6.- Block diagram of the Bendix (airborne) multispectral scanner (M2S).



(a) 525G (Blue-green) B-3 BAIRD-Atomic optical filter.

(b) 5540 (Green) B-3 BAIRD-Atomic optical filter.

(c) 12 (Yellow) Wratten optical filter.

(d) 89B (near-Infrared) Wratten optical filter.

Figure 7 continued. - Photographs of the James River from 5.3 kilometers altitude on May 28, 1974. In photographs 43 to 46 is shown the Hopewell area from City Point to Maycock Point. In photograph 47 is shown City Point again and in 48 and 49 is shown the James at the mouth of the Chickahominy River. The time of the photographs is between 10:35 and 10:50 Eastern daylight saving time.

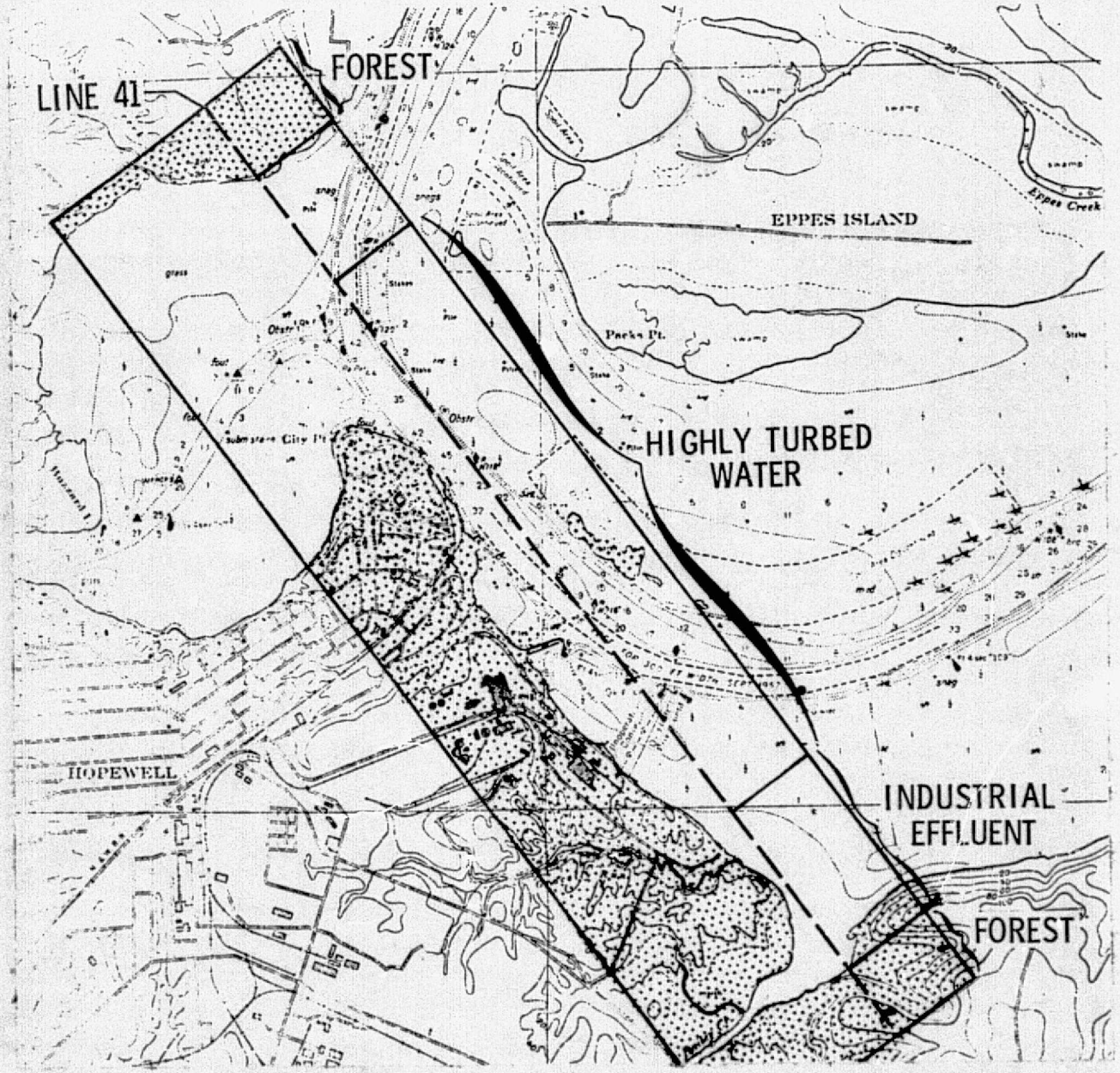


Figure 8.- Location of Scan Line 41 used for MOCS preliminary analysis.

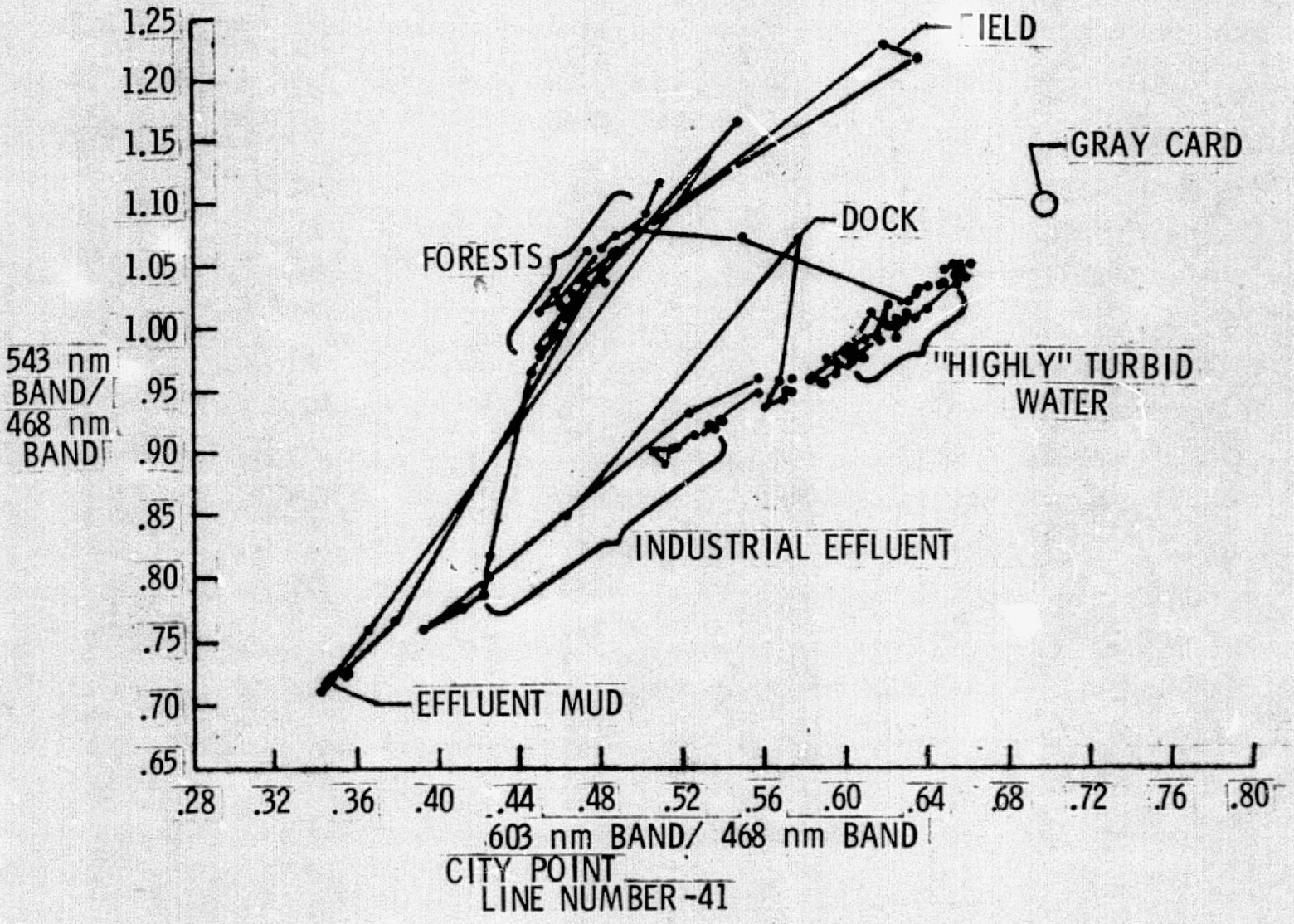


Figure 9.- MOCS identification of points along Scan Line 41 (shown in figure 8).

Test site 1, Norfolk (see figure 3 a).

Test site 2, Hopewell (see figure 3 b, c).

Test site 3, Hog Island (see figure 3 d).

Figure 10. - Multispectral scanner (Bendix M2S) imagery of test sites on May 28, 1974. Band 5 (.58 - .62μ) shown.

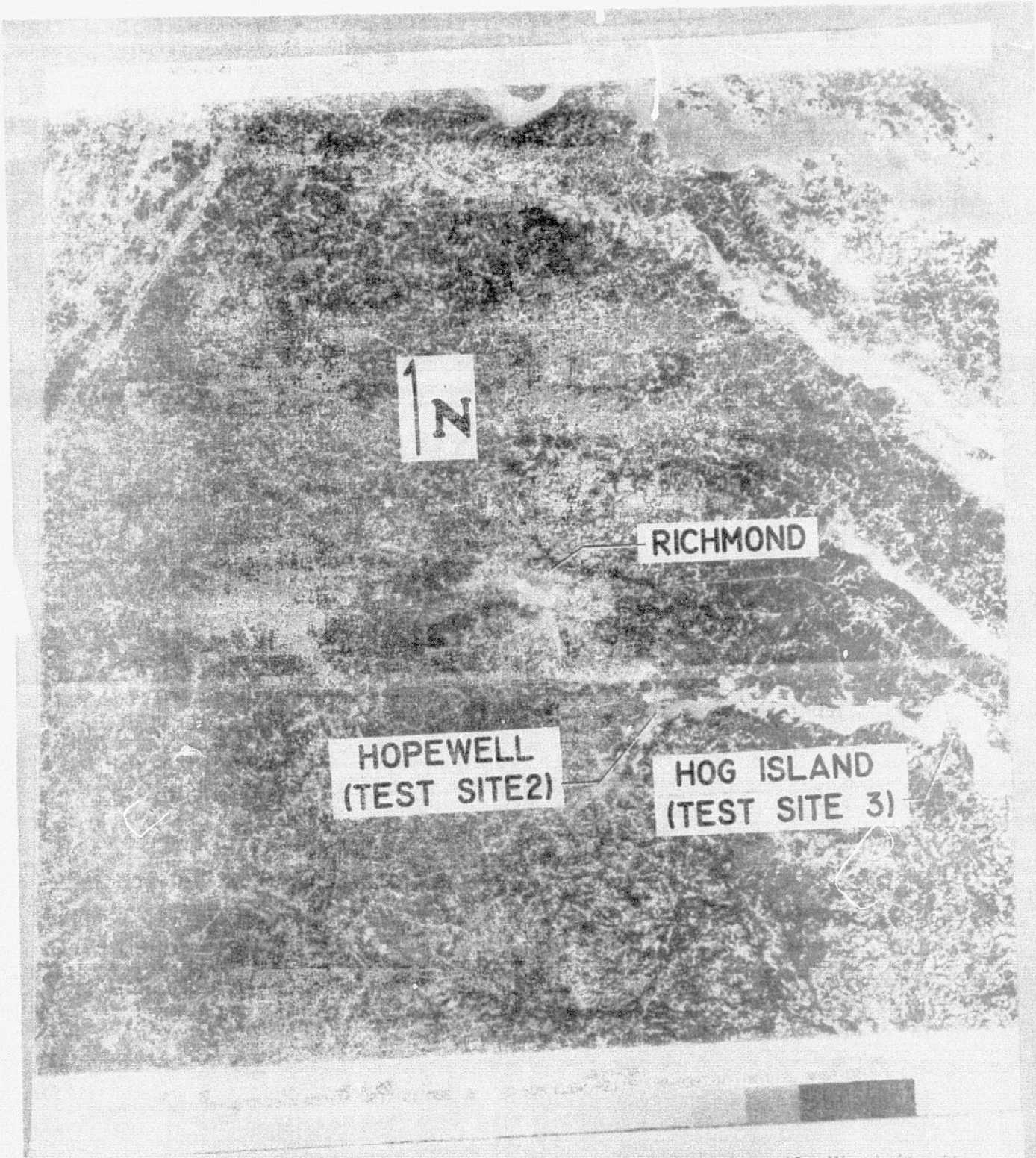


Figure 11.- LANDSAT imagery of the upper James River and Hopewell, Virginia, on May 28, 1974 (Band 5 of ERTS Observation 1674-15131).